LIBRARY
U. AUG 8 1898 S.
PATENT OFFICE.

MARINE ENGINEERING.

Vol. 2. NEW YORK, AUGUST, 1898. No. 8.

RECENT IMPROVEMENTS IN MISSISSIPPI RIVER FERRYBOATS AT ST. LOUIS.

BY WILLIAM H. BRYAN.

Upon western rivers the steel railroad bridge has largely replaced the ferry service of days past and has brought much fame to the civil engineer. For many reasons, principally commercial, there will, however, always be a large amount of passenger and freight traffic carried on in specially built ferry steamers. This is particularly true in large cities having important railroad terminals on the opposite shores, as is the case at St. Louis.

NEW DOUBLE-ENDED FERRYBOAT, THE ANDREW CHRISTY, IN SERVICE AT ST. LOUIS.

The service required of the ferryboat is peculiar. It differs widely from that of other river craft. The distance between opposite landings is usually small, and the run of but few minutes' duration. Fully as much time is consumed in loading and unloading as in running, so that the machinery is rarely in operation half the time, and only for short periods. The engines hardly have time to get thoroughly warmed up to their service when they are shut down. This, of course, precludes the highest economy.

The traffic also is peculiar. In many cities—New York for instance—there is a heavy passenger business, but in St. Louis this is quite small. Here by far the larger percentage of the work done is heavy teaming, although there are some lighter vehicles and stock. A considerable part of the coal coming to St. Louis is unloaded from the cars into large wagons in East St. Louis, and hauled across on the ferries. A great deal of St. Louis frieght, both east and west bound, is transferred in this manner.

The average daily business done by five of the Wiggins' Ferry Company's boats at St. Louis for a period of several months was 1,010 vehicles and 1,700 passengers. Averaging the former at 30 cents each and the latter at 3 1-2 cents, the

Copyright, 1898, by The Marine Publishing Co., New York.

revenue is:

For vehicles	$303.00 =	83⅓%
" passengers	59.50 =	16½%
Total	$362 50 =	100 %

Or an average for each boat of $72.50

All ferry service requires that loaded teams have ready access to and from the decks of the steamers, which requirement is met by specially constructed landing places or docks. At St. Louis movable wharf-boats are used, these being necessary on account of the great fluctuation of the water level.

The earliest type of river ferry was a raft propelled by poles. These, of course, could only be used on small and shallow rivers, and where the current was not swift. Later came the flat-boat, propelled by oars or sails, this being in time enlarged to accommodate a wagon and team. The earlier boats of this character were so small that the team was unhitched and the wagon taken apart, and even then several trips were sometimes necessary to transfer a single wagon, with team and load. These boats continued to be enlarged until they could accommodate a single team without unhitching. With increase of size came the necessity for more power. This was met by horse boats, which were quite common in the early days, and which are still in occasional use in out-of-the-way districts, and for very light traffic. Two forms of these boats were common: In one the horse worked a treadmill, and in the other he was hitched to a radial arm driving a central pinion to which the machinery was geared. The propelling wheels were located either at the side, center or stern. Blind horses were found preferable for this work. In some cases, where the river was not too wide, nor the current too swift, heavy ropes or cables were thrown across, and the boat made its trips by being fastened to this rope by a sort of trolley arrangement. Some of these were quite ingenious, the river's current against the deflected steering oar furnishing ample power to propel the boat to and fro across the stream. This arrangement was, of course, subject to frequent interruption—particularly where the river was subject to floods, and where there was much drift wood, or frequent passages of steamers.

Later came the pontoon bridge, a number of small flat-boats located side by side extending entirely across the river, the boats being well anchored in position, and provided with suitable decks and guards, the whole forming a continuous roadway. This arrangement was subject to all the difficulties of the last plan described, and has had but limited use.

With the invention of the steam engine and its successful application to vessels, the steam ferry came into general use. These vary widely in design and construction. They have, however, some important characteristics in common, viz., the requirement for large deck space, to accommodate numbers of loaded teams; the ability to handle themselves quickly and readily in crowded harbors, and to receive and discharge their cargoes with the least possible loss of time. Aside from these features their construction varies radically with the character of the streams on which they operate, the depth of water, the swiftness and direction of the current, its fluctuations in level, the distance between landings, etc. The type of machinery varies with the cost of the fuel, the character of the water required for the boilers and sometimes with peculiar local conditions of service.

The ferry in New York harbor is as different from that at St. Louis, as the characteristic Hudson river steamer is from that of the Mississippi. The New York ferry is a double ender, operating equally well in either direction. It has two pilot houses. Formerly they were all side wheelers, but this type has lately been superseded to a considerable extent by steamers with screw propellers at each end.

The ferry on western rivers, however, is quite different. Permanent docks cannot be used on account of the great fluctuation of water level, which is as much sometimes as 40 ft. or more. There is usually a speed of current of from 3 to 7 miles an hour in a fixed direction. Fuel is usually inexpensive, but the water available for boilers is often of the most objectionable character. Both the side and stern wheel types of steamers have been used to a limited extent for ferry service. The former has usually a large deck space forward and sometimes some space between the boilers and engines.

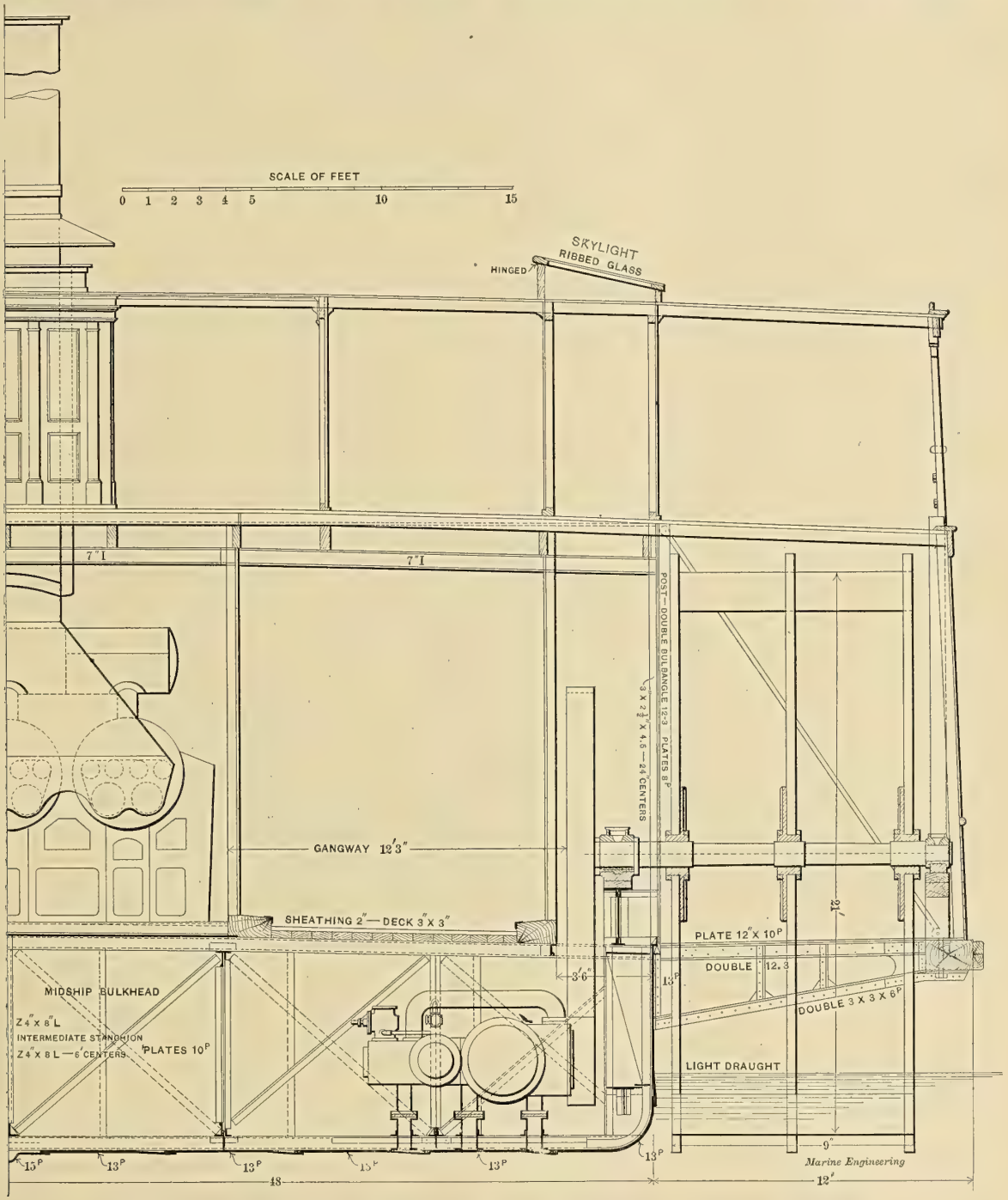
The characteristic type of western river ferry steamer, however, is the center wheeler, in which the hull is built with a central recess in the rear, in which the water wheel operates. This is known to old river men as the "catamaran" construction. Forward the hull is of the usual construction, but just aft of the center the central portion of the hull is cut away, leaving an open space. Back of this point, the hull is continued in two separate and independent divisions. Sometimes these are carefully modeled, both inside and outside, and sometimes only on the outside, the inner portion being left in plain vertical shape. The central wheel is of large diameter, working quite slowly, and is driven by a high pressure single cylinder non-condensing engine of the usual four valve lever type. The boilers are of the horizontal type common on western rivers, having long return flues. This type of ferry is well shown in the photograph on page 5.

While satisfactory in many ways this type of ferry is open to serious criticism in some respects—particularly in the matter of fuel consumed. The boiler used has an efficiency under 50 per cent., and the engines have a water rate of probably 40 lbs. per I. H. P. hour. In view of the fact that boiler efficiencies of 75 per cent are not uncommon now-a-days, together with water rates as low as 13 lbs., it can readily be

seen that there is a vast field open for fuel saving. The increased cost of fuel saving machinery, however, and the very low price at which fuel is bought in this market, have heretofore prevented much being done in this direction.

In the summer of 1896, the Wiggins Ferry Company, of St. Louis, engaged Frank E. Kirby, of Detroit, Mich., as their consulting engineer, to design a new ferry steamer on more modern lines. Mr. Kirby completed the design in October, 1896, and contracts were let for the work shortly thereafter. Ed. J. Howard, of Jeffersonville, Indiana, took the contract to build the hull and cabin, and the Detroit Dry Dock Company, of Detroit, Mich., to furnish and erect the engines.

Actual construction continued from February to September, 1897. The hull was built at Jefferson-



HALF CROSS SECTION OF MISSISSIPPI-RIVER FERRYBOAT, ANDREW CHRISTY.

ville, Indiana, but on account of threatened low water was taken to Cairo, Illinois, for completion. She was practically finished at this point, but it was thought best to tow her to St. Louis,

and she reached this city on September 15, 1897. Here the finishing touches were put on, and she was examined by the U. S. inspectors, and began regular service September 26. This steamer, which was named the Andrew Christy, first went into regular service on a new route established between the foot of North Market street, St. Louis, and the C. & A. Ry. Depots, East St. Louis, a distance of a little over a mile in a direct line. Here she made twenty-six round trips a day, operating between 6 A. M. and 7 P. M., making half-hourly trips. This route proving unprofitable, however, it has been discontinued, and the "Christy" has been put into service on one of the company's old routes, from the foot of Carr street, St. Louis, to the C. & A. Ry. Depots, in East St. Louis. Here she displaced two of the company's old style steamers, doing the same work with only one crew, and with only the fuel consumption of one boat.

The "Andrew Christy" has been specially adapted for excursion service, having very roomy upper decks. It is proposed to make a specialty of this service by issuing tickets at 10 cents entitling the holder to remain on the boat as long as he desires.

The accompanying engravings give full particulars of the construction of this steamer. It will be seen that she differs materially from the characteristic Mississippi river ferry. In the first place her hull is of steel, instead of wood. The boat is a double ender, and a side wheeler. Her deck arrangement is quite different from the ordinary type. The hull is 176 ft. long between perpendiculars, and 7 ft. deep. Her beam is 48 ft., which added to the 12 ft. guards, makes a width of 72 ft. over all. The steel hull plates are 5-16 in. and 3-8 in. thick. The framing is made of 6 in. 13 lb. bulb angles, spaced 20 in. The beams are of 6 in. bulb angles, with centers 20 in. and 24 in. There are three fore and aft trusses; and no hog chains whatever. The weight of steel in the hull is approximately 215 tons. It was expected that the draught of the boat, with coal and water on board, would be 3 ft., but she actually trims on a little less than 30 in. Her launching draught was 16 in.

There are three water tight bulkheads, extending from side to side, one located amidships, and the others near each end. The hull coefficient, is 75 per cent. There are five athwartship truss frames, in addition to the three water-tight bulkheads. The hull construction—which is the same at both ends—is very full in body, and the boat appears to ride over the water, instead of cutting through it. There is a keel of 15 lbs. shaped steel, projecting 3 in. An independent rudder is of course fitted at each end, each controlled from the pilot house at the opposite end.

The engines represent the most radical departure from ordinary Mississippi river practice. Each side wheel is controlled by an independent non-condensing horizontal geared engine located in the hold. These are of the cross-compound type, with high pressure cylinders 16 in. dia., low pressure cylinders 32 in.; stroke 24 in. The pistons have metallic packing, and the piston rods are of steel. The speed in regular operation varies between 75 and 125 revolutions per minute, and is ordinarily kept between 80 and 90. The engines are of the reversing type, the valves being actuated by the ordinary Stephenson link notion, the operating levers being located in the engine room on the main deck. The levers controlling both engines are located on the main deck, side by side, just back of the boilers, and are handled by a single engineer, with great ease and promptness. There are three levers for each engine, one operating the link-motion connected to both high and low pressure valves, one for throttle, and the third controlling a pipe which admits high pressure steam into the low pressure cylinders to throw the engine on center when this is necessary. Piston valves are used on the high pressure cylinders, and double ported slide valves on the low pressure cylinders.

The crank shafts are of the built-up type 6 1-2 in. dia., and are set 90 deg. apart. The cranks are of cast steel, 5 in. thick. As the engines themselves are not visible from where the engineer stands, tell-tales are provided to indicate their motion. There is considerable vibration, particularly on the upper decks, and at full speeds, although the engines are usually worked slightly out of step to reduce this. The vibration is due principally to the spacing of the buckets of the wheels which are pitched wider than usual, in order to make her a powerful ice breaker. The engine crank shaft is geared by means of a 3 ft. pinion with a 12 ft. spur wheel on the side wheel shaft. These gear wheels are made of gun iron, machine moulded by Poole, of Baltimore. They make considerable noise—particularly when stopping or reversing, as the teeth are not cut. Some fear has been expressed that these gears might break, but investigation shows that they are performing similar service elsewhere with satisfaction. Three advantages result from the use of gearing: deck space is economized, weight is reduced, and a higher piston speed permitted, the latter being necessary for good steam efficiency.

The ratio of speed between engine shaft and side wheel being four to one, the normal speed of paddle wheel is between 20 and 30 revolutions per minute, averaging probably about 22. The water wheels are 21 ft. outside dia., with 14 buckets each 9 ft. long by 18 in. wide. The wheel shafts are of hammered iron, 11 in. dia., at their largest dia. and 7 in. at the smallest. There are three wheel centers on each shaft as will be observed in the cross section on page 3.

The cut-off in the high pressure cylinder is, of course, adjusted by the link motion, the latest point being about three-quarters. In ordinary

service, however, the cut-off is about one-half in this cylinder.

The engines described above are more powerful than are ordinarily placed on boats of this size. This increase was made with a view of making her particularly effective when operating in floating ice, and the anticipations have been fully realized in service.

The steam connections to each engine are 4 1-2 in.; exhaust 8 in., the two combining into one 10 in. passing through the exhaust head and pipe on upper deck. Although an open heater is used no trouble has been experienced with oil in the boilers. There is but small receiver capacity, and no reheating coils.

The boilers are of the ordinary river type, three in number, all set in one furnace, with the usual river setting of sheet iron lined with brick.

OLD TYPE OF MISSISSIPPI-RIVER FERRYBOAT WITH CENTER WHEEL, AT ST. LOUIS.

Dimensions as follows: 48 in. diameter, 28 ft. long; 6 flues, two being 13 in. and four 8 in.; grates 5 ft. long by 14 ft. 2 in. wide; heating surface, 1,977 sq. ft.; grate surface, 71 sq. ft; ratio 1 to 27.85. This is a very small ratio, but not smaller than is common with boilers of this type which it is frequently necessary to "crowd" far beyond their rating. In view of the fact, however, that the boilers steam easily, it would probably be safe to cut down the grate surface a little, particularly if artificial draft is secured by turning the exhaust into the stack, which is not the case now. The rated horse power of these boilers at 8 sq. ft., is 247, but they are undoubtedly worked far beyond this frequently.

The boilers are cleaned internally every second Sunday, and externally about once a week. They are allowed a pressure of 157 lbs. and usually carry about 145 lbs. The thickness of the shells is .29 in.; with longitudinal seams double riveted; and rivet holes drilled. The material is 65,000 lbs. tensile strength steel.

Two improvements are noticeable in these boilers which undoubtedly make them more economical than the ordinary river boiler, viz: the use of smaller tubes, and greater length of shell. The chimney is of steel, of the usual construction, 50 in. dia. and about 40 ft. high above grate level. Natural draught only is used, and the direction of the operation of the boat seems to make no difference in the steaming qualities of the boilers. The estimated weight of the boilers, engines, and water, is 150 tons.

The auxiliary machinery is neither complicated nor elaborate. The boiler feed apparatus consists of a large "doctor" of the usual Mississippi river type, with two cold water plungers 5 3-4 in. dia., two hot water plungers 4 5-8 in. dia., and stroke 14 1-2 in.; all single acting. One side of this "doctor" pumps cold water from the river, and discharges it into the open heater overhead, from which it is taken by the other side of the "doctor," and forced into the boiiers. The fresh water entering the heater passes through a coil before being discharged. As more water is pumped into the heater than is taken out, there is a constant overflow into the suction pipe, which warms the entering water to some etxent. As these "doctors" are liable to stick on the center it is frequently necessary to by-pass part of their

capacity in order to keep them moving, so that there is considerable waste of energy. On the "Christy" injectors serve as reserve feeders.

There is a large fire pump, and a direct connected electric lighting plant of 4 Kw. capacity, there being 78--16 c. p. lights wired on the boat. The generating unit consists of a Westinghouse engine and a Fuller dynamo.

In operation this steamer has given most satisfactory results. No tests have been made, but as nearly as can be estimated she burns about 50 per cent. less fuel than the other Wiggins steamers. She is also much faster, and it is claimed that she is the fastest steamer in the St. Louis harbor. On timing her on one trip from East St. Louis to North Market street, she covered the distance in 8 1-2 minutes, being run slow part of the time on account of shoal water, and at no time at full speed. This would be equal to about 7 miles per hour against the current, which was running probably 3 miles, a total of 10 miles per hour. It would seem therefore that she can easily make 12 miles should occasion demand. She is not operated usually as a double ender, as it involves some complication in the handling, and is furthermore found unnecessary. She does not handle quite as well with the rudder as the other boats, but the steering facilities afforded by the two side wheels make it possible to handle her with much greater ease, and she can be turned in considerably less than her own length. In practice, one of the rudders is kept permanently pinned in place, and only one pilot house is used.

The decking and upper works of the boat are constructed of wood in the usual manner and are very complete. The weight of the entire woodwork is estimated at 150 tons.

As might have been expected, the design of this ferryboat was not looked upon with favor by the old time river men, but her fine performance has in a large degree silenced criticism.

Negotiations are now pending for the construction of one additional boat of the same general character. If any changes are made they will be in unimportant details, such for instance, as using steam steering gear, operating both rudders from one pilot wheel, and adding one arm to each side wheel. Some changes may also be made in the hull model to improve the steering. It is possible that surface condensers may be applied to the next boat. These will furnish distilled water to the boilers, so that the latter may be of much more efficient type, occupy less space, and in all probability be located in the hold, thus leaving more deck room for traffic. There is room for doubt, however, as to whether the fuel bills will be reduced sufficiently to warrant the additional first cost, greater complication of parts, and liability to derangement, increased weight and space occupied. Fuel is quite cheap at St. Louis, the engines are in operation but a small fraction of the time, and rarely under conditions favorable to the highest economies.

In the following table there will be found some comparative figures on the Andrew Christy and the Alonzo C. Church, which is a fairly representative steamer of the type heretofore employed by the company.

The exact cost of the Christy could not be secured, but it approximated very closely to $50,000. The iron hull and wood work cost about $30,000. The cost of the ordinary wooden hull ferry steamer is a little over $30,000.

COMPARISON BETWEEN WIGGINS FERRY STEAMERS.

	Alonzo C. Church.	Andrew Christy.
When built	1893	1897
Length	172 ft. 3 in.	178 ft.
Beam	43 ft. 3 in.	48 ft.
Depth	6 ft. 5 in.	7 ft.
Tonnage, net	332.62	522.92
Material of hull	Wood	Steel
Draught	42 in.	29 in.
Boilers—Number	3	3
Diameter	46 in.	48 in.
Length	18 ft.	28 ft.
Number of flues	6	6
Diameter of flues	2-13 and 4-7 in.	2-13 and 4-8 in.
Heating surface	1,196	1,977
Thickness of shell	.26 in.	.29 in.
Pressure allowed	147 lbs.	157 lbs.
Engines—Number	1	2
Type	Simple	Compound
Diameter cylinders	28 in.	16 in. and 32 in.
Stroke cylinders	72 in.	24 in.
Steam pipe, diameter	7 in.	4 1-2 in.
Estimated horse power	400	500
Average speed, revolutions per min.	15	80
Approximate cost of completed steamer	$35,000	$50,000

Both steamers were built at Jeffersonville, Ind. The engines of both are horizontal, non-condensing. The boilers are all of the ordinary horizontal return flue type, externally fired.

MARINE GASOLINE AND GAS ENGINES AS USED IN MODERN MOTOR BOATS.—II.

BY CECIL H. PEABODY, M.E.

In the first article of this series the general principles of gas engines and the conditions which control their efficiency were discussed. We will now consider some of the operations which are essential to the running of all such engines, and which consequently control the design of gasoline engines used for propelling boats and motor carriages.

Fig. 1 of the first article (repeated here for convenient reference) represents the indicator diagram taken from an engine using kerosene oil, but since there is no essential difference in diagrams taken from explosive engines, whether they are gas, gasoline or oil, it may be considered to be the typical diagram for all recent internal combustion or gas engines. Four strokes are required to complete the cycle. The first stroke represented by *a b* draws in an explosive mixture of air and gas or vapor; the second stroke compresses this mixture as represented by *b c*. After the compression is complete the mixture is ignited and there is an explosion or sudden rise of pressure represented by *c d*. The next stroke, represented by *d e* is the expansion or working stroke. At or near the end of the stroke the gases are released as represented by *e f*, and the fourth stroke *f a* ex-

pells the spent gases from the cylinder. When all these operations are performed, in one cylinder, two complete revolutions of the engine and four strokes of the piston are required to complete the cycle. Of the four strokes only one is a working stroke; two strokes are transfer strokes, during which the gases operated on are drawn into or expelled from the cylinder; one stroke,

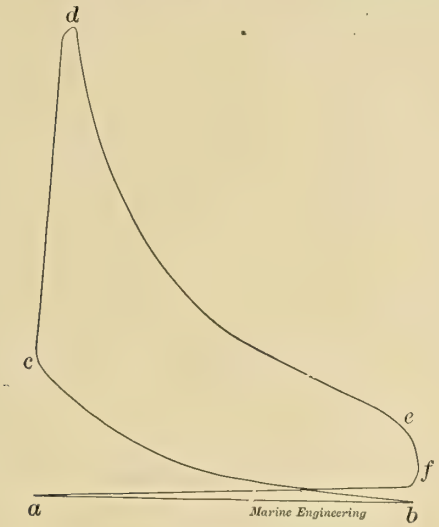


FIG. 1.

during which the charge is compressed, must be made at the expense of power taken from the fly wheel of the engine. We now see why so large a fly wheel is required for engines of this type. Almost all stationary engines, have all four operations performed in one cylinder, as a large fly wheel, and a massive foundation are readily supplied to such engines. Some large stationary engines have two cylinders and thus, by alternating the explosions, can get one working stroke for each revolution of the engine. A 400 horse power gas engine at Godalming, England, has four cylinders and can have two explosions for each revolution, so that it compares favorably in regularity of running with a steam engine.

When internal combustion engines shall be employed for propelling ships, it will probably be found advisable to use four or more cylinders with their pistons connected to a single propeller shaft, but the reduplication of parts and consequent complication appear to be inadmissable for small boats. For this reason many gasoline engines have the transfers represented by the line *f a* and *a b* Fig. 1, performed by a separate piston, or what amounts to the same thing, by the under side of the working piston.

Fig. 3 shows how this is done by the Sintz gasoline engine. The crank end of this engine is enclosed and forms a reservoir for the explosive mixture of air and gasoline vapor. On an up stroke of the piston the air and gas are drawn in, and on the next down stroke they are slightly compressed by the under side of the piston. The engine has no valves, the flow of gas to and from the cylinder being controlled by the piston itself. For this purpose there are two sets of ports cut through the cylinder walls near the lower limit of the stroke of the piston head. The port on the left side is for the exhaust of spent gases, as indicated on the figure; the port on the right is for the admission of a fresh charge. On the down or working stroke the piston overruns first the exhaust port at the left, and the spent gases which have a pressure considerably higher than that of the atmosphere, escape through the exhaust pipe. After the release is nearly completed, the gases from the crank end, previously compressed by the under side of the piston, flow in through the port at the right hand, as indicated by the arrow, and displace the remaining spent gases. The piston consequently does not need to make the transfers and can have a working stroke for each revolution of the engine. Each up stroke is a compression stroke, and each down stroke is an expansion or working stroke.

The method of removing the transfers from the duty of the working piston, gives at once the advantages, that the power of the engine of a given

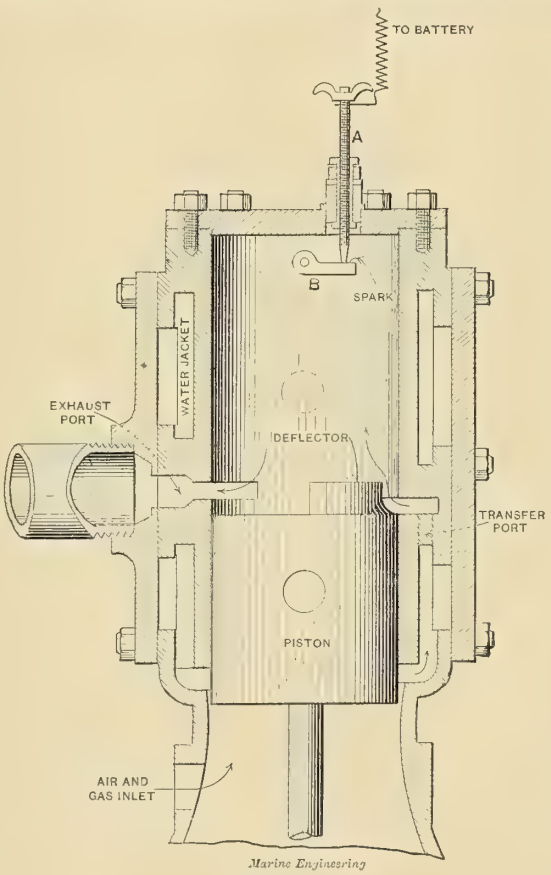


FIG. 3.

size is doubled, and the steadiness of running is much improved. And yet, a single cylinder engine of this type will require a fly wheel of considerable size and weight.

Unfortunately the advantages gained by taking the transfers of gas away from the working piston are likely to be modified, because the incoming fresh charge, instead of sweeping the spent gases entirely out of the cylinder, mingles with them more or less. In some cases the fresh gases may even get as far as the exhaust port before the spent gases are properly expelled, and escaping unburned, may lead to a direct loss. The makers of the Sintz engine, realizing this danger, have placed a deflector on the piston which throws the incoming fresh charge toward the upper end of the cylinder. This engine has incidentally the advantage that no valves are required for controlling the flow of gas into and out of the cylinder.

It may be pointed out in passing that a two-stroke motor like the Sintz engine would need two cylinders to give as much regularity of running as a single cylinder steam engine; and that four cylinders would be required to give the equivalent of a two crank steam engine.

One of the most important devices for a gas engine is the igniting arrangement. Three types of igniting arrangements have been used for gas engines: (1) The flame ignition, (2) the hot-tube ignition, (3) the electric ignition. The flame ignition does not appear to be well adapted to use on boats and will be dismissed with the statement that it consists essentially in carrying a burning mass of gas and air into the cylinder of the engine at the proper instant. The mass of gas must of course be ignited by a flame or gas jet outside of the engine, and must be carried in a closed space on the way to the cylinder. To keep the flame alive in this closed space and to raise the pressure so that the flame shall not be blown out when communication is opened with the cylinder, some of the compressed combustible charge from the cylinder is allowed to leak into the flame chamber on the way to the cylinder.

The hot tube igniter is represented in Fig. 4, as it was first used on the Atkinson engine. It consists simply of a wrought iron tube (1) communicating with the interior of the engine cylinder (4) and closed at the outer end. The tube is kept at a red heat by a Bunsen flame (2) which is enclosed by a non-conducting shield (3) to protect it from draughts and to reduce radiation. The Atkinson engine to which this was applied was so constructed that the piston uncovered the opening of the pipe to the cylinder at the proper time. In engines of the ordinary type a valve must be provided to open communication with the cylinder when the explosion occurs, and further it is customary to provide a separate exhaust for the tube, so that it shall be sure to be filled with fresh gas for each ignition.

Very curiously we find that both the earliest and least reliable, and the most recent and approved igniting arrangements are electrical. The earlier type had a pair of platinum points carried

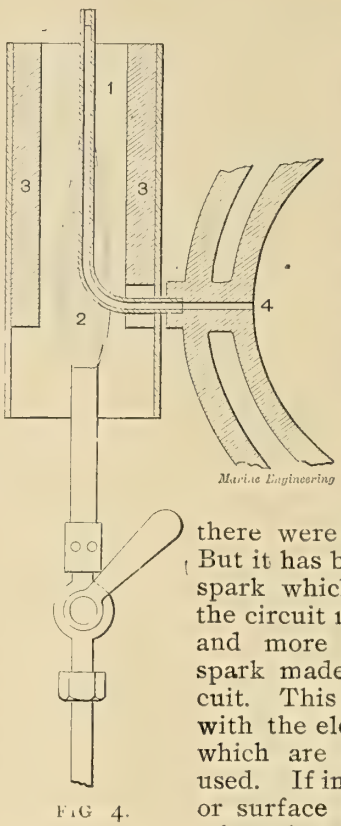


FIG 4.

through an insulated plug into the engine cylinder. A primary battery and a Ruhmkoff coil were provided to produce a spark between the points when the circuit was closed by a mechanism that was driven by the engine. Nothing seemed more simple; but it was found that the spark was both feeble and uncertain, and that there were frequent misfires. But it has been found that the spark which is formed when the circuit is opened, is longer and more intense than the spark made by closing the circuit. This is very noticeable with the electric gas lighters, which are now so commonly used. If in addition one point or surface is drawn over the other when the spark is formed both surfaces are kept bright and in good condition. The spark thus formed is known as a "wiped spark." The acting points or surface must of course be inside the engine cylinder, which leads to somewhat more complication than was necessary with the older device.

The igniting device for the Sintz engine is shown by Figs. 3 and 5. In Fig. 2 A is an insulated adjusting screw which receives one wire as indicated. B is a lever which receives motion through an axis or spindle that comes through the side of the cylinder. At the proper time B is swung down, and produces the spark for igniting the charge. Of course there is a spark when the circuit is closed, but it is feeble and does not ignite the charge. On the engine shaft there is an eccentric which drives a pump for circulating water through the water jacket, and also operates the igniting arrangement. The eccentric rod drives a rod as shown at E F, Fig. 5. This rod D carries a projecting ring G which strikes against the steel point L on a cast iron casing J. This casing is connected to the rod or spindle H which carries the lever B, Fig. 3, not direct, but through a clock spring. When the eccentric rod is down the clock spring throws the casing around to the right till it is arrested by the stop M; when the eccentric rod comes up, the ring G strikes the point L and revolves the casing J to the left and raises the lever B (Fig. 3) till it strikes the point A; then the casing J goes on and winds up the spring until

the point L slips off the ring G, whereupon the casing and the lever B are thrown around to the right by the spring, first breaking contact and forming a spark between A and B, and then coming to rest against the stop M.

Another very important question concerning gas engines is the method of controlling or governing them. The standard method for governing stationary engines is by omitting an occasional explosion. This is accomplished by drawing back the cover which opens the gas supply so that it fails to act. The consequence is that the engine draws in air without an admixture of gas, and though all the other operations are performed in regular order, including one attempt at ignition, there is no explosion, and no power is developed. Such a method, as compared with the easy and nice regulation of a steam engine, appears to be very crude. It has the advantage that every working cycle is made at full power and efficiency; in fact, the working cycle following a blank cycle is more than usually efficient. Of course a two cylinder, and still more, a four cylinder engine, shows less fluctuation of speed, on account of regulation by omitting a working cycle, than is found for a single cylinder engine.

Some attempt has been made to adjust the power of a gas engine by controlling the proportion of gas and air, but since gas engines work most efficiently with poor or weak mixtures of gas and air, and since too weak a mixture will

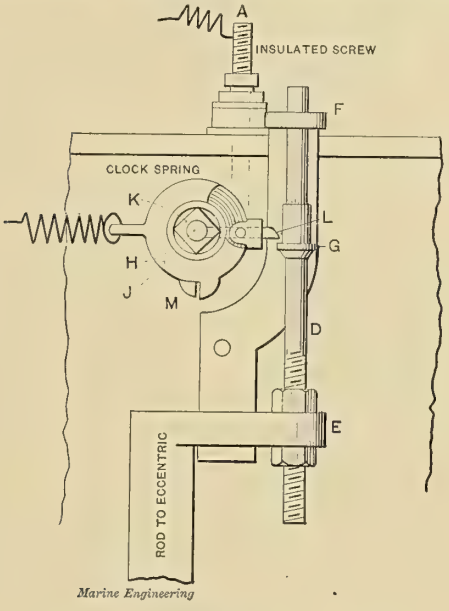


FIG. 5.

fail to explode, it is evident that this method cannot be relied upon for governing an engine.

There remains now one more way of controlling a gas engine, and that is by throttling the combined gas and air supply. The result of this method is to draw in the gas and air supply at less than atmospheric pressure, and consequently there is a marked reduction in power. In the first place there is less fuel introduced into the cylinder, and consequently less heat is produced by the explosion, and in the second place the mixture has a low pressure at the beginning of compression and a relatively low pressure at the end of compression, which of itself directly reduces the power of the engine. Some engine builders claim that their engines are as efficient at low power as at high power, when controlled by this method, but it is difficult to see how this may be. Unfortunately but little disinterested testing of gasoline engines has been done thus far, and many builders of such engines consider that their interests are served by reticence concerning both the construction and operation of their engines.

DESCRIPTIONS OF THE SPANISH VESSELS DESTROYED AT SANTIAGO JULY 3.

In the supplement with this issue we present several original views of the Spanish vessels captured or destroyed by the American blockading squadron at Santiago, July 3. Our readers are of course familiar with the story of the fight, which the press of the country has published, not only from the correspondents at the front but from officers and men on the ships who participated in the battle. The vessels destroyed included the pick of the Spanish navy, each one a magnificent ship representing the highest development of scientific effort in her class.

The Cristobal Colon, as readers of our April issue will recollect, was an armored cruiser of about 6,800 tons displacement. She was built recently at the Ansaldo yard at Sestri Ponenti for the Italian Government, to be called the "Guisippe Garibaldi," but shortly before the war sne was purchased by the Spanish Government and renamed. Her dimensions were: length, 328 ft.; beam, 59 ft. 9 in., and mean draught, 23 ft. 3 in. In general appearance she resembled somewhat vessels of our battleship class. One peculiarity of her construction was the location of her military mast between the funnels, which were spaced in a fore and aft direction. This caused the quick recognition of the vessel by our sailors when she emerged from the harbor of Santiago on July 3. Her offensive powers were very strong for a vessel of her dimensions. A 9.84-in. rifle was placed in each end barbette, giving a wide angle of fire; ten 5.9-in. rapid-fire guns were carried also in the main battery, five on each side. These guns could be trained ahead or astern in a considerable arc, as well as used for direct broadside fire. Besides these guns, in the secondary batteries, there were six 4.7-in. rifles, ten 6-pounders, ten 1-pounders, all rapid firers, and two Maxim automatic machine guns. There was very ample protection, too, for the vessel and gunners. She had a complete Harveyized steel belt 6 in. thick and 8 ft. 3 in. wide, about the water line and above this the protection was carried to the upper deck for a distance of 120 ft.

amidships. The bases of the barbettes of the bow and stern chasers were protected by 6-in. steel bulkheads, and the barbettes themselves were 5 in. thick. The protective deck ranged in thickness from about 3-4 in. to 1 1-2 in. and the deck above the central batteries was nearly 2 in. thick. There were also four torpedo tubes for Whitehead torpedoes. Many special electrical devices were employed for the rapid manipulation of the guns. These included training and loading gear for the 9.84-in. guns and for the several ammunition hoists, and for this reason the generating plant was quite extensive.

The propelling machinery consisted of two sets of triple-expansion engines driving twin screws. The engines had cylinders 42 in., 63 in. and 97 in. dia. by 46 in. stroke. To secure lightness and strength steel was used extensively in the construction of the engines, including the frames and bed plates. Piston valves were fitted to the high pressure cylinders and double-ported slide valves to the intermediate and low pressure cylinders. The engine motions and shafting were hollow steel forgings. The main condensers were of delta metal, with a cooling surface of 14,600 sq. ft. The air pumps were 33 in. dia. by 21 in. stroke and were direct driven off the low-pressure crosshead. A complete system of hot feed was part of the auxiliary equipment. Steam was supplied by twelve water-tube boilers of the Niclausse type, built in France. They were placed in two groups of six each, divided into sections of three by water tight compartments. The boilers were set back against the fore and aft bulkhead, and, as will be noticed in the drawing on page 11, they were placed both forward and abaft the engines and higher up in the ship than is usual. With steam pressure of 145 lbs. and nearly 100 revolutions, the engines indicated, collectively, 10,700 horse power. On trial a speed in excess of 19 knots was attained with natural draft, and at sea, in good trim and with a clean hull, a rate of speed of about 17 knots could be easily maintained. With forced draft and for spurts this could be largely exceeded.

The bunker capacity of the Cristobal Colon was 600 tons, but in case of emergency she could carry 1,200 tons, and there was provision for carrying liquid fuel in the double bottoms. Her complement was 500.

Our artist has represented the Cristobal Colon with her big guns mounted fore and aft, showing the vessel fully equipped. According to reports from the American squadron these guns were not in place during the Santiago fight. The cause of their absence is said to be a delay in carrying out the tests of this portion of the armament, so that the warship had to sail without a complete main battery.

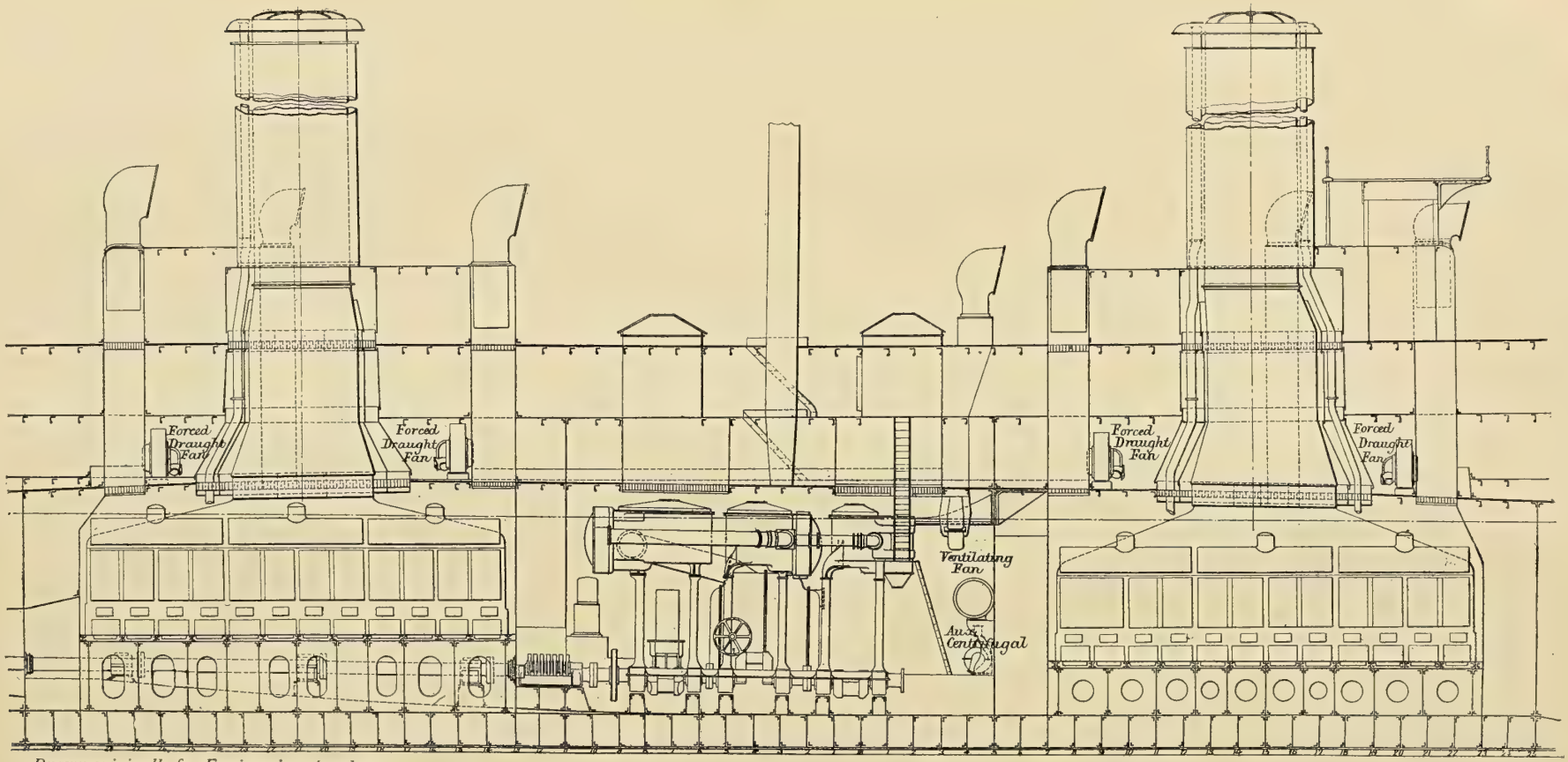
The other three ships destroyed by our fire were classed as armored cruisers with barbettes. They were alike in general dimensions and equipment, differing only in minor details, many of which were introduced since the ships were in commission. Their names and dates, according to the time of launching, were, Infanta Maria Teresa, 1890; Vizcaya, 1891, and Almirante Oquendo, 1891. Many of our readers will recall having seen the two first named, the "Teresa" at the Columbian Naval Review in the North River in 1892, and the "Vizcaya" at the Staten Island anchorage in the upper bay at New York early this spring, on which occasions the photographs reproduced in our supplement were taken. They were twin screw vessels of 7,000 tons displacement, each fitted with two smoke pipes and two masts with fighting tops. They were built at Bilbao, in Spain. The chief dimensions were: length, 364 ft. over all, 340 ft. between perpendiculars; beam, 65 ft. 2 in., and mean draught, 21 ft. 6 in. They were protected with heavy armor, disposed according to the shaded portions shown in the drawing in our Supplement. Armament of each consisted of two 11-in. Hontoria breech-loaders mounted singly in turrets forward and aft, ten 5.5 in. Hontoria rapid firers, mounted five on each side, eight 6-pounder and ten 1-pounder rapid-fire guns and several machine guns. Each was fitted with six torpedo tubes, with both above and below water discharge.

Armor included a 12-in. steel belt at the water line, 5 ft. 6 in. wide, 12-in. steel on the big-gun turrets and 8 in. glacis plates over the engine room, 12 in. protection for the conning tower and a protective deck ranging in thickness from 2 in. to 3 in. Coal bunkers were interposed between the sides and vitals, according to the usual practice, giving additional protection from machine gun and secondary battery fire.

The engines were of the usual inverted triple expansion type, developing 9,500 horse-power with natural draft and 13,000 with forced draft. The corresponding rates of speed were 18 1-2 knots and 20 knots. Steam was raised in six Scotch boilers, four double-ended and two single-ended. Coal capacity for 1,050 tons was provided, sufficient to carry each vessel nearly 10,000 miles at 10 knots speed. The cost of each vessel's hull and machinery was $3,000,000.

These ships were of a very handsome model, and when properly painted and cleaned, were unusually fine looking specimens of naval architecture. The rake of the masts and stacks and the neatness of design of the upper works, combined with the symmetrical hull lines, made a very pleasing and elegant combination.

Of the vessels of the Spanish squadron there now remain to be described the torpedo-boat destroyers Furor and Pluton, the destruction of which was even more complete than that of the larger vessels. These boats attracted probably more attention in professional and lay circles, previous to the fight, than the big cruisers. This was because their effectiveness was so largely a matter of conjecture until they sank as impotent wrecks in Cuban waters. While of the familiar



Drawn originally for Engineering, London.

LONGITUDINAL SECTION OF THE SPANISH CRUISER CRISTOBAL COLON, THROUGH ENGINE AND BOILER ROOMS.

destroyer type, they were of unusual dimensions, or considerably larger than the boats in service in other navies. Both were a product of the famous Thompson Works at Clydebank, Scotland, the builders who turned out the former American liners New York and Paris, now the cruisers Harvard and Yale of our navy. The Furor was launched in 1896 and the Pluton in 1897. They were very similar in size and dimensions, the Pluton being slightly the larger of the two. The Furor measured 220 ft. in length, 22 ft. beam and 5 ft. 6 in. draught, and was of 380 tons displacement. She was fitted with twin-screws driven by four-cylinder triple-expansion engines located in a compartment abaft the boilers. Steel was extensively used in their construction, not only in the frames but the cylinder tops and bottoms, pistons and all rods; also the bed-plates and the crank, thrust, and propeller shafts. Hollow forgings were introduced wherever possible. The piston-rod heads and guides were forged solid with the rods, and the crosshead pins were carried fixed in the connecting rods. On the ahead side the guides were filled with white metal working in cast iron guide faces fitted with water jackets. The astern guide faces were of bronze. There were eight main bearings in each engine. Balance weights were fitted to the crank shafts and at high speeds there was remarkable freedom from vibration. The air pumps were driven di-

rect off the forward ends of the crank shafts. Brass was used for the condenser shells and they were arranged so that the cooling water was forced through the tubes by the movement of the boat through the water. Auxiliary circulating centrifugal pumps were fitted for use in port. Four Normand type water-tube boilers were used. These were contained in two water-tight compartments with two firerooms. The uptakes of the forward and aft boilers led into the similarly situated funnels, and the two center boilers discharged into the middle funnel, which accounts for its large area as shown in the engraving in our Supplement. Forced draft on the closed stokehold system was fitted, fans in the stoke hold taking air through the above deck cowls and discharging into the room. Very complete automatic feed apparatus was fitted with Weirs' feed heaters and pumps. She also contained an evaporating plant capable of handling over 3,000 gallons a day, and there was also a distilling condenser which could supply 560 gallons a day of aerated fresh water for the use of the crew. There were many other auxiliaries, including independent air pumps and bilge pumps and ejectors, and steam steering gear was fitted.

The armament included two 14-pounder rapid-fire guns, one mounted on top of the conning tower forward and the other on a platform aft, also two 6-pounder rapid-fire guns and two 1.45-in. automatic guns, one on either side forward. There were also two 14-in. Schwartzkopff torpedo tubes mounted centrally on the upper deck so as to give discharge on either side.

Accommodation for the officers and men was quite elaborate. There were teak upper decks, in addition to the complete steel deck, and there was a very full electrical equipment for lighting and ventilation.

On trial with a load of 75 tons the Furor easily came up to the contract speed of 28 knots with 6,000 indicated horse power, and proved herself a handy, speedy boat. Her complement was 67.

The Pluton measured 225 ft. long; 22 ft. 6 in. beam; and 5 ft. 9 in. draught, and displaced 400 tons. She was fitted with triple-expansion engines built at Clydebank and Normand water-tube boilers. Her coal capacity was 100 tons. Her armament was the same as that of the Furor. On trial, with a load of 73 tons on board, she showed a mean speed of 30.12 knots on the measured mile, and during a continuous run of one and one half hour's duration a rate of speed of 30.02 knots; on a two hours' trial, with natural draft, the rate was 22.7 knots.

Properly handled, the destructive capacity of these vessels was enormous. With their automatic guns alone they could send out a frightful storm of small shells, and the large guns, which could be fired with great rapidity, possessed armor-piercing power.

The sixteen destroyers recently provided for by Congress are to be of this type.

TRANSATLANTIC LINERS SECURED BY THE GOVERNMENT FOR TRANSPORTS.

It is not often that an entire fleet of transatlantic liners changes ownership as suddenly as did the vessels of the Atlantic Transport line last month. They were purchased by the United States Government for use as transports under the control of the War Department, additional to the many fine coast liners previously secured by the Government and used for transporting troops to Cuba. Negotiations for the purchase of the ships were opened by the Government and the sale closed almost before these were generally known. The fleet purchased includes seven modern vessels which have been in the London trade. Of these ships five are sister ships, named Mobile, Mohawk, Massachusetts, Manitoba, Minnewaska, and the others are the Mississippi and Michigan. They were all built by Harland & Wolff, at Belfast, Ireland, and are comparatively new vessels.

The first named five are about 5,600 tons gross. They are fitted with twin screws and triple-expansion engines. Their dimensions are: Length, 445 ft.; beam, 49 ft.; depth, molded, 30 ft. The engines have cylinders 22 1-2 in., 36 1-2 in. and 60 in. by 48 in. stroke.

Both the Mississippi and the Michigan were also built by Harland & Wolff. They are single screw vessels of about 3,600 gross tons. Their dimensions are: Length, 370 ft.; beam, 44 ft.; depth, 26 1-2 ft. The engines are triple-expansion, have cylinders 25 1-2 in., 42 in. and 70 in. by 51 in. stroke.

The service maintained by the Atlantic Transport Line with this fleet included passengers, cargo and live stock. An extensive trade was also done with dressed beef carried in refrigerating chambers. The passenger accommodation on each ship was limited in extent and there was only one class-cabin—each vessel having accommodation for less than 100 passengers. Their general appearance is well illustrated in the view of the steamer Manitoba here printed.

Another fine ocean vessel secured by the War Department is the American liner Berlin, which, as the Inman liner City of Berlin, was the crack ship of the Western ocean in her day. She is an iron vessel 448 ft. 6 in. long between perpendiculars, 44 ft. beam, and 34 ft. 9 in. deep. She was built by Caird, of Greenock, Scotland, in 1874, and, as is shown in the engraving, she is of handsome model with the old clipper bow. Her original machinery was long ago replaced by a modern equipment, which includes triple-expansion engines with cylinders 41 in., 65 in. and 101 in. dia. by 66 in. stroke. Steam is generated in eight single-ended boilers 13 ft. 2 1-2 in. dia. and 11 ft. 4 1-2 in. long, at a pressure of 150 lbs. She is equipped with Ellis and Eaves induced draft. The Berlin is fitted with a single screw 21 ft. 6 in. dia. and 31 ft. 6 in. pitch. She has a continuous sea speed of about 15 1-2 knots, and for short runs

Netherlands-American S. S. Obdam *Atlantic Transport Line S. S. Manitoba.* *American Line S. S. Berlin.*

TYPES OF TRANSATLANTIC LINERS SECURED BY THE U. S. GOVERNMENT FOR USE AS TRANSPORTS.

has exceeded 16 knots. As a transport she will have accommodation for 2,000 troops, in addition to her own crew, and will have cabin accommodation for about 250 officers. She will also carry about 1,500 tons of coal and will have stowage space left for about 1,000 tons of freight.

Our other illustration shows the S. S. Obdam, of the Netherlands-American line, which was also secured for a troopship. She has been in the transatlantic trade between New York and Rotterdam. This vessel, which was formerly the S. S. British Queen, was built by Harland & Wolff, Belfast, Ireland, in 1880. She is a steel ship, 410 ft. long, 39 ft. beam and 28 ft. 9 in. deep, and is 3,700 gross tons. She was fitted with new machinery at Rotterdam last year, including triple-expansion engines with cylinders 28 3-4 in., 46 1-2 in. and 74 in. dia. and 51 in. stroke; also two double-ended Scotch boilers, each with six furnaces. Her sea speed is 15 knots.

To replace the ships sold to the Government, the Atlantic Transport line has purchased from the Wilsons-Furness Leyland line the fleet of steamers recently put into the London service. These ships are sisters of about 9,000 gross tons. They are the Alexandria, Boadicea, Cleopatra, Victoria and the Winnefreda. They are fitted up for a limited number of cabin passengers and large cargo carrying capacity. They were built at various British yards. Their general dimensions are: Length over all, 490 ft.; beam, 52 ft. 3 in.; depth, molded, 34 ft. 6 in. They have been built to conform to Lloyd's 100 A1 class. Each vessel has three complete decks and under the shade deck there is accommodation for about 700 head of cattle. Triple-expansion engines and Scotch boilers and very complete outfits of auxiliaries are installed in each ship. The passengers are accommodated in a large bridge-house on top of the upper deck and they have a promenade the full width of the ship. In the passenger spaces the decorations are extremely fine. The conveniences for passengers are in every respect up-to-date. The dining saloon, which is at the forward end of the bridge, is finished in mahogany and satinwood. The music-room is decorated in old English style, and the smoking-room is finished in teak, with walls covered with embossed leather.

Description of Vessels for Auxiliary Fleet.

In our list this month of auxiliary vessels secured by the Navy Department there are details given of about sixteen vessels, ranging from tugs to ocean frighters, which were added to the Navy since the publication of our previous lists. This makes a total up to date of between 130 and 140 vessels added to the Navy since the war preparations began. Referring to our third list, in the July issue, the old name of the tug J. D. Jones is there retained in the naval service. This has been changed to the "Apache," by which name the tug is now known.

WARSHIPS AND AUXILIARY VESSELS RECENTLY ACQUIRED BY THE UNITED STATES NAVY BY PURCHASE, CHARTER OR TRANSFER (*FOURTH TABLE*).

Old Name and Date.	Old Class.	Length.	Breadth.	Depth.	Draught.	Tonnage.	Horse Power.	Speed, Knots.	Where Built.	Hailing Port.	Former Owners.	New Class.	New Name.
Confidence, '80	Iron tug	85	17 6	9 5	.....	85 gross	.....	.....	Philadelphia, Pa.	Boston	.....	Tug	Waban
Elfrida, '89	Steel yacht	102	18	12 6	7 11½	123	215	10.6	Harlan & Hollingsworth	Shelbourne, Vt.	Dr. W. Seward Webb	Aux. Gunboat	Elfrida
Elizabeth Holland, '98	Steel freighter	254	39 3	§17 2	17 7¾	1,801	1,100	13	Sunderland, England	British	F. S. Holland	Collier	Leonidas
Hercules, '88	Iron tug	110	21	11	.....	141 gross	550	14	Camden, N. J.	New York	Standard Oil Co.	Tug	Chickasaw
Ice Boat No. 3, '73	Ice boat	195 9	33 3	.....	12	.....	.....	.....	.....	Philadelphia	City of Philadelphia	Coast Patrol	Arctic
Joseph Holland, '98	Steel freighter	254	39 3	§17 2	17 7¾	1,801	1,100	13	Sunderland, England	British	.....	Collier	Hannibal
Kanawha, '96	Wood yacht	146	17	10 6	7	127 gross	600	14	Seabury, Nyack	New York	John P. Duncan	Aux. Gunboat	Kanawha
Lighter No. 18	Wood tow barge	94 6	23 8	6 3	2 3	....	.....	.....	.....	Philadelphia	Phil. Trans. & Lt'ge Co.	.....	Trans. Lighter
No. 295, '98	Steel ya ht	153	20	10 6	8 6	159 gross	550	16	Roach's Yard, Chester	.....	{ Del. River Iron Ship Bldg. & Engine Works	Aux. Gunboat	Sylph
Norse King, '90	Freight steamer	340	41 1	26 3	23	2,985 gross	440 N.	.....	Sunderland, England	London	W. Ross & Co.	Distilling Ship	Rainbow
Oil Barge No. 55	Tow barge	120	30	10	7	.....	.....	.....	.....	New York	Standard Oil Co.	Water Barge	WaterBgeNo 1
*Pedro, '83	Iron freighter	330 2	38 3	27 8	.....	2,872 gross	400 N.	10	Newcastle-on-Tyne, Eng.	Bilbao	Cia de Nav. La Flecha	Collier	Hector
Port Chalmers, '91	Steel meat str.	371	46 1	27 7	.....	4,154 gross	459 N.	8	Sunderland, England	London	Federal S. N. Co.	Supply Ship	†Glacier
Ravenna, '82	Freight pass. s.r.	393	40	28	17	3,256	3,000	14.5	Denny, Dumbarton, Scot.	.....	.....	Collier	Scipio
Sylvia, '82	Iron yacht	139	18 6	9 4	8	136 gross	.....	13	Stephens, Glasgow	New York	Ed. M. Brown	Aux. Gunboat	Sylvia
†Titania, '79	Iron freighter	232 6	35	24 2	8 6	1,966	250 N.	.....	Sunderland, England	Hamburg	A. Kirsten	Collier	Marcellus

* Captured by Blockading Fleet in Cuban waters. The Pedro was formerly the S. S. Lilburn Tower.
‡ Former names S. S. C. Fellinger and S. S. Mercedes. § Hold. † Temporarily named the "Delmonico."

Armed Yacht vs. Torpedo-Boat Destroyers.

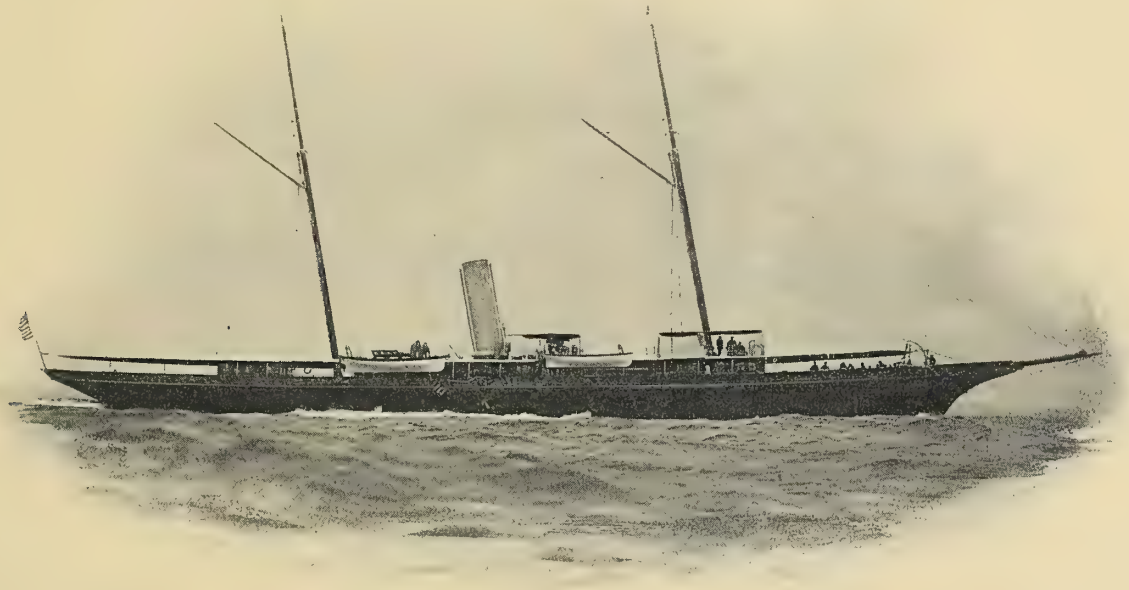
As remarkable a departure from the accepted in naval tactics during the Santiago fight (a battle full of surprises) was the attack made by the converted yacht Gloucester upon the Spanish torpedo-boat destroyers Pluton and Furor. During the fight, while the larger vessels of our squadron were busy pounding the Spanish cruisers, and giving but little attention to the destroyers, Lieutenant-Commander Richard Wainwright, of the Gloucester, started for the destroyers. In the earlier stages of the fight they naturally distanced her, but later, when the boats stopped their attempt to run away the Gloucester closed with them again and used her battery of 6-pounders with terrific effect. Though the boats were armed with guns as heavy as 14-pounders, their fire was not effective and they went ashore mere wrecks. The Gloucester's commander was one of the executive officers of the ill-fated "Maine" when she was destroyed in Havana harbor.

So interesting was the performance of the auxiliary gunboat Gloucester that we here present an exterior view showing her as she appeared as the S. Y. Corsair. She was one of the best known American steam yachts before her purchase by the navy. Her owner, J. Pierpont Morgan, is commodore of the New York Yacht Club, and consequently his yacht was flagship of the club squadron.

The "Corsair," now "Gloucester," is entirely a home product. Her designs were drawn by J. Beavor-Webb, of New York, and she was built at Philadelphia in 1890-'91. She is a very graceful vessel, a good sea boat, and has been entirely satisfactory as a luxurious pleasure yacht, and later as a gunboat of the U. S. Navy. Her dimensions are: Length, 241 ft. 6 in. over all; 204 ft. on water line; beam, 27 ft. 2 in.; depth, 16 ft. 5 in., and draught, 13 ft. She is a single-screw vessel and has triple-expansion engines with cylinders 21 in., 33 in., and 54 in. dia. and 30 in. stroke, of 1,900 indicated horse power. She is fitted with two Scotch boilers which carry a pressure of 175 lbs. per sq. in. Her gross tonnage is 560 tons. Her sea speed is 18 knots.

Trial Trip of the Cruiser Kasagi.

An official trial of the Japanese cruiser Kasagi was run over a course off New England in July. This vessel, which was built at Cramp's yard for the Japanese Navy, is one of the protected class of cruisers designed to have high speed. On trial with natural draft a rate of 20.6 knots was recorded, and with forced draft the average for a twenty-mile run was 22.76 knots, a fraction in excess of the contract speed, which was 22.5 knots. The trial was in every respect successful, and, we understand, the vessel has been taken over by the Japanese Government. Her dimensions are: Length, 374 ft. 6 in.; breadth, 48 ft. 9 in.; depth, 30 ft. 6 in., and trial draught, 7 ft. 9 in. Her displacement is 4,900 tons. She is fitted with twin screws and triple-expansion engines, giving a total of 17,000 indicated horsepower. Her armament, which will be fitted at the Armstrong works in England, will include two 8-in. breech-loading rifles, ten 4.7-in. rapid-fire guns; also twelve 12-pounders and six 2.5-in. Hotchkiss guns. She is also fitted with torpedo tubes for Whitehead torpedoes.



AUXILIARY GUNBOAT GLOUCESTER AS SHE APPEARED WHEN S. Y. CORSAIR.

HIGH PRESSURE AT SEA WITH SOME CONSIDERATION OF TYPES OF BOILERS.—IV.

BY W. R. CUMMINS.

Taking the usual proportions of heating surface in an ordinary return-tube boiler, and debiting each part with its own deficiency, the decrease of efficiency amounts to 9.5 per cent on the total surface. That is to say, assuming a steam economy of 18 per cent for 250 lbs. pressure, the boilers, if the ordinary return-tube type, could have 18 per cent less grate, but only 8.5 per cent less heating surface than the lower pressure boilers. As regards the combustion chamber, the return-tube boiler is very well off. The furnace crown, however, especially with small furnaces, is apt to cool down the gases given off by green fuel, but the fire-brick bridge acts as an equalizer of temperature and tends to counteract the cooling effect.

In order to institute a means of comparison between different types of boilers in the matter of combustion chambers, take, say, two single-ended boilers 14 ft. 6 in. by 10 ft. 6 in., with a heating surface of 3,750 ft., and a grate surface of 118 ft. We may take one-half the volume of the furnaces above the bars as forming part of the combustion chamber. This, together with the fireboxes, gives a total capacity of 480 cubic feet for the two boilers. Nothing better in the way of dividing up the gases into small streams, and ensuring their distribution over the heating surface could be desired than the arrangement of fire tubes of the present boiler. The distance traveled by the gases from the firebars to the uptake also allows ample time for the heating surfaces to absorb the desired amount of heat. In the boilers we have here taken as an example the mean distance traveled by the gases from the firebars to the uptake is 17 ft.

As regards the quantity of water over the highest heating surface, the boiler under question is perhaps superior to any other. Take the same two boilers as above indicating, say, 1,000 indicated horse power, the weight of water, 6 in. over the highest heating surface, would be 8,788 lb. Then, if the engine were using 16 lb. water per indicated horse power per hour, the feed could be shut off for 30 minutes without exposing the heating surface.

The return-tube boiler is fairly accessible for cleaning. All parts are fairly get-atable, except, perhaps, the firebox backs when the combustion chambers are deep. It is, however, a matter of great difficulty to renew any of the internals except the tubes. The furnaces are occasionally made that new ones may be substituted without disturbing the remainder of the structure, but if the firebox backs, or back tube plates require renewing, it is cheaper in the end to build a new boiler entirely. The return-tube boiler has a large space at the bottom, where grease and mud may collect without doing any harm. The water circulation, however, is very inferior on account of the large body of water under the line of the fire-bars, and the want of anything corresponding to the downcomers of the water-tube boilers. When raising steam from cold water some means of mechanically circulating the water in the boiler is essential, otherwise it may easily happen that the body of water under the line of fire-bars remains quite cold even when steam is being generated above, thus causing serious racking stresses in the boiler. Finally, as regards the cost of the return-tube boiler, it will certainly not cost less than a boiler working at 150 lbs. pressure and doing the same work, as, owing to the increased thickness of the heating surface and the increased temperature of the water, the higher pressure boiler will need to have almost as much surface as the lower pressure one, consequently its size cannot be reduced to any extent. This, added to the extra scantlings required for the higher pressure, will undoubtedly bring up the cost to that of the lower pressure boiler.

The other types of boiler which have been used on board ship are the locomotive type and the navy type. These have, however, been discarded for various reasons, hence the author passes on to the water-tube types. These can be divided roughly into two classes: those whose tubes are more nearly vertical than horizontal, and those whose tubes are more nearly horizontal than vertical. To the former class belong the haystack boiler, Yarrow's, Thornycroft's, Normand's, Fleming & Ferguson's, Reed's, Blechynden's and others; and to the latter class belong Bellville's, Babcock & Wilcox's, Niclausse's, Anderson & Lyall's, and others. The haystack boiler is totally unsuited for 250 lbs. pressure, although it is lighter and occupies less space than any of the shell boilers.

For the purpose of comparison we may take as one class the Yarrow, Thornycroft, Normand, Reed, and Blechynden boilers. As regards thickness of heating surface, these boilers are very favorably situated, as almost the whole of the surface, including that surface which takes up the radient heat of the fuel, is composed of tubes of small diameter, and, being exposed to internal pressure, may consequently be made very thin. The combustion chambers of these boilers are almost ideal, viz., a large free space over the fire-bars. To compare the volume of the combustion chambers of these boilers with that of the Scotch boiler, take, for example, three of any of the above types, having the same grate surface as two Scotch boilers, viz., 118 sq. ft. The volume of the combustion chambers for the three boilers will be about 525 cu. ft., which is more than that of the two Scotch boilers. Hence, this class of water-tube boiler, as regards combustion, should be superior to the Scotch boilers, provided the same quantity of coal were burnt per sq. ft. of grate, as the volume of the combustion chamber should be determined by the weight of coal burnt.

REPORT OF THE "MAINE" NAVAL COURT OF INQUIRY.

(*Third installment*).

Lieutenant-Commander Richard Wainright, in continuation was asked:

Q. Do you consider that the way she swung at the time she blew up was an unusual way for her to swing?

A. I never remember her swinging in that direction—remaining in that direction—for any length of time. She probably swung past that direction several times, but not to remain in that direction for any length of time.

Lieutenant John W. Blandin, watch and division officer of U. S. S. Maine, when called as a witness, testified:

Q. Do you know of any special orders that were issued by the commanding officer while in Havana in order to guard the ship more securely than at any other place?

A. The quarter watch was on watch all night. Small-arm ammunition was placed in the belts of the marines and of the quarter watch in the gun divisions, one hundred rounds. The boxes of 1-pounder and 6-pounder ammunition were stored in the cabin pantry (which is not used for anything else), the armory, and the pilot house. Sentries were posted on the forecastle and on the poop, with cartridges in their belts, but with orders not to load their pieces unless ordered by an officer. Orders were given to see that strict watch was kept, which was done. I think those were the principal precautions taken.

Q. During the time you stood watch in the harbor of Havana, did you ever know of any hostile demonstration afloat, in the way of boats approaching the ship that had to be warned off?

A. None whatever.

Q. How was the ship swinging at the time of that explosion?

A. She was riding to the ebb current.

Q. The ship is now lying pointing almost toward the admirality house or Machina. I suppose that is the way she was when she exploded?

A. I don't remember her heading, but the *Alfonso* was on our starboard quarter, the little gunboat was almost astern, and the *City of Washington* was on our port quarter.

Q. Would you be able to tell the court whether she was riding in an unusual direction for that harbor?

A. It didn't strike me so from the general appearance. I took no notice of her heading. She swung around the buoy for three weeks, about. She had probably been on every heading.

Q. Did she seem to be pretty steady on that heading that night?

A. Yes, sir.

Q. She was heading steadily in that direction?

A. She seemed to be. I had no cause to suspect any change.

Q. You know that ships swing a great deal in the harbor of Havana. Could you not tell us whether, from the time you took the deck until the time of the explosion, the *Maine* seemed to be heading almost steadily in one direction?

A. So far as I know, she was, from the bearings of other ships.

Q. How soon after the explosion do you think the forward part of the ship was under water?

A. The forward part, almost within a minute. I should estimate that, at the most, two minutes after the explosion the quarter deck was knee deep in water. She was on bottom in, I think, less than three minutes, all over.

Lieutenant George P. Blow, who was officer of the day on February 15, was next called, and graphically described the scenes following the explosion:

Q. Will you state to the court what you experienced during that explosion? We wish to know what you felt, what you heard, or what you saw.

A. I was writing at the time, and heard forward, and apparently at some distance—that is to say, well up in the bow, as far as I could judge from the sound—an explosion.

Instantly the lights went out. I rushed out of my room to see the cause of it, and before I could get more than probably 6 feet from my room a second and much more violent explosion followed. This explosion I would describe as being a continuous explosion, lasting for some seconds, and accompanied by the falling of lights, electric fittings, furniture, and by a crashing and rending of metal, and immediately by a sharp heel of the ship to port; the sound of rushing water from forward, and the cries and screams of men from about amidships. My first impression was that we had been fired on, and I remember feeling surprised that it should have been by such a heavy gun. When the second explosion occurred, followed by the listing of the ship, I recognied the fact that the ship was sinking, and had been blown up.

My impulse had been at first to go to my quarters, but at the second explosion I abandoned all thought of this, and realized that it was a question of whether I could reach the deck or not before the ship sank. A sharp heel of the ship, as I rushed forward feeling my way along the starboard bulkhead, caused me to lose my way amidst the wreckage, and for probably a moment I was confused as to my position. I soon found the bulkhead again, and, feeling my way along, reached a small china jar on top of the starboard steam heater, and recognizing this by feeling, found the starboard door leading forward. This door was closed and jammed. It could not be opened. I then felt my way across the deck to the port door. The list of the ship, which had probably closed the starboard door, had kept the port door open, and I had no difficulty in finding it. Stepping through the door, I reached the ladder, and ran into some one in the dark.

Q. What ladder was that? The one just outside the bulkhead?

A. Yes, sir; just outside the bulkhead, leading up to the wardroom proper.

Q. It leads into the cabin passage?

A. Yes, sir. We both fell, owing to the inclination of the deck, but, helping each other up again, we immediately crawled up the ladder, which was then nearly vertical. I am under the impression that this ladder fell immediately afterwards, as I heard a crash behind us. The water was then rushing in on the berth deck, though it was not quite up to the ladder, as she was heeled to port. Reaching the main deck, I felt my way through the starboard door in the after superstructure out on deck, and was surprised to find that everything was pitch dark, as dark as it had been below.

Q. That starboard door opens right out on the starboard deck?

A. It opens right out on the starboard deck; yes, sir.

Q. After passing through that you found it dark?

A. I found it perfectly dark there. I was surprised at the time to find it so dark. This was probably due to the fact that the quarter-deck awning had been dragged down by the fall of the third cutter. As I passed through the door I ran against some one hanging from the poop deck rail, who asked me to give him a push up on deck. This I did, and believing that there must be some good cause for his having taken that way of reaching safety, I quickly followed. At this time the main deck was still above water.

On reaching the poop deck I glanced forward and found the whole forward part of the ship a mass of confused wreckage, and apparently submerged up to and above the main deck. There were about a dozen men only to be seen on the poop deck. Among these I recognized the captain and the executive officer, Lieutenant-Commander Wainwright, who were giving orders to get out the boats for the purpose of saving the lives of the men in the water.

On the starboard side the beam and forward there were cries for help. Realizing at a glance that my boat, the third cutter, and that all the boats, in fact, forward, were gone, I turned aft to help to get out the only boats remaining. I found the gig manned and about to be lowered. I lowered the forward fall, and was surprised to find that the boat only went down about 6 or 8 feet. Thinking the stopper might have passed, or the blocks jammed, I asked the man in the bow if everything was all right. He replied yes. I asked him why the boat would not go down. He informed me that the boat was afloat. By that time the water had nearly reached the top of the superstructure deck. I then went forward again, and noticed that the wreckage had broken into flames, and I heard some one, I think the executive officer, say to the captain: "There is the wreck of the fire ship which they have sent down on us," pointing to the wreckage forward, which was now illuminated from the burning cellulose.

I then went to the port side to assist in lowering the barge. I found that she had already been lowered and was afloat. Before that, however, I would like to insert something. I am a little too fast. Before going forward again one of the midshipmen—I think it was Mr. Cluverius—came and asked me if he could be of any service. I told him to jump in the gig and take charge and save what life he could on the starboard side, which I believe he did. After this I went to the port side to assist in lowering the barge and I found that she was already in the water and afloat. There were already, I think, four men in her, however, to man her. So I went back again and called several who were standing on the poop and put them in the boat, and afterwards got in myself. I took charge of the boat, ordering the man at the helm to steer around on the starboard side, where most of the cries for help had been heard. After shoving off I found Lieutenant Jungen was in the boat, and he being my senior I turned the boat over to him and requested that he put me back. He said it was impossible, which was perfectly right. He pulled completely around the ship, and only succeeded in picking up one man on the starboard side, as we became involved in the wreckage and débris which was floating from a beam around the bow. The barge being very long, and only half manned, was very difficult to maneuver. We were continually backing and pulling out.

In that way we did not get around as quickly as we might have done. By this time the wreckage was all in flames, and I called Mr. Jungen's attention to the fact that I thought I saw men on the forecastle, as I supposed it to be, and asked him to pull in there and see if he could not get them off. We headed in for the wreckage, but ran into other wreckage, which we found out there to be the submerged portion of the forecastle and forward superstructure. We backed out and again pulled in toward the flames. We then found that it was the after part of the middle superstructure, abreast of the port crane. There were several boats there, which had already taken off all the men, so we pulled around on the port quarter, and again reported to the captain that the boat was there ready to take off anybody else. In the meanwhile the captain had ordered the ship to be abandoned. Mr. Wainwright asked us if we were all right. We told him yes, and asked the captain if he would not get in the barge. He replied, "No; I want my own boat," and then ordered all of our boats to go on board of the Ward Line steamer the *City of Washington*. He then put his orderly and every one else into the gig and got into the gig himself. We obeyed orders and went aboard the *City of Washington*.

Lieutenant Carl W. Jungen, watch and division officer, in the course of his examination, was asked:

Q. When did the lights go out in reference to this second explosion?

A. About simultaneously.

Q. Then you think the dynamo may have been destroyed at the second explosion?

A. Yes, sir.

Q. And not by the first?

A. Not by the first.

Naval Cadet D. F. Boyd, Jr., had a remarkably narrow escape, which he narrated to the court:

Q. Please state what you saw, heard, and felt.

A. I was sitting in the steerage reading at the time. The lights went out. A crashing booming was heard. I was struck in the back of the head with a splinter, and remember no more of the explosion.

A. When I collected my wits I grasped Assistant Engineer Merritt by the hand and told him to go up on deck. I pulled him out in the passage in the after torpedo room. We groped along the bulkhead until we came to the turn going over to the port side. At this moment the ship sank down amidships and heeled over on the port side. The rush of water swept us apart. I grasped the steam pipe overhead—the small steam-heater pipe—and worked my way down toward the steerage ladder, but it was gone. I worked my way over to the port side—on this steam-heater pipe—hoping to escape through some hole on the port side. The water was rushing through the air ports, so that I was not able to hang onto this small pipe. I grasped the torpedoes that were triced up under the deck beam, and, twining both arms and legs around it, I worked my way inboard toward the hatch, feeling the deck most of the time to find the hatch. The water at this time was almost over my head; almost up to the deck. Some burning cellulose flared up on deck, and I saw the hatch and made for it. I escaped through a mass of débris, on the hatch part of which was the second cutter.

Q. Again referring to the shocks, what kind of a shock did you first feel?

A. As well as I can describe, the shock was more that of a large freight train being coupled up together.

Q. That was the first shock?

A. That was the first shock.

Q. The other was continuous, so far as you can remember, you say?

A. Yes, sir.

Gunner Joseph Hill, who had served in the "Maine" for twenty-one months, was questioned in his examination about the electric light fittings:

Q. Were magazines and shell rooms always carefully locked after they had been opened?

A. Yes, sir.

Q. And the keys turned in?

A. Yes, sir.

Q. There was always a regular care taken in the delivery of the keys and the locking of the shell room and magazines?

A. Yes, sir.

Q. Are the magazines lined with wood?

A. No, sir; not as I remember. The plates are bare, of course, and the only woodwork I remember there is the stowage racks, holding powder, tanks, and shells. They are made fast to the metal bulkhead.

Q. Is there any electric wiring that leads into the magazine that would be dangerous?

A. No, sir; the wires seemed to be well insulated. Of course they led into the light box, but, as I remember, they came down through the deck, and then went at an angle into the light box itself. As I remember it, the wires went through a metal casing.

Q. You considered the wiring perfectly secure?

A. Yes, sir; of course it may have been woodwork painted over white, but I never examined it very closely. It looked very much to me as if it was metal.

Q. You never had any trouble with the light boxes in the way of grounding—with the lights in the light boxes?

A. Yes, sir; the dynamo tenders found considerable trouble in keeping the magazine lights in order. They always gave as an excuse that the system was grounded down around the boxes.

Q. But the wiring laid directly from the upper deck into the boxes, in two metal cases?

A. Yes, sir; but as I remember it, I think it went down through the deck in some places, and then went at an angle into the light box itself.

Passed Assistant Engineer Frederick C. Bowers, of the "Maine," was examined at length. During his testimony he was asked:

Q. Please state to the court what precautions have been taken on board the *Maine* during her commission against spontaneous combustion of coal?

A. The order has been to inspect the bunkers every day, and log it. In the case of every bunker that had an escape door, we have always opened those doors to examine the bunkers; and generally the coal that has been in the ship the longest has been used the first, as near as possible.

Q. As far as you know, these orders have been carried out, have they?

A. Whenever I was on duty they were.

Q. When were you on duty last on board the *Maine?*

A. The 14th day of February.

Q. The day before the explosion?

A. Yes, sir.

Q. You came off that morning at what time?

A. At 8 o'clock.

Q. Can you give the history of bunker A16, which is the port bunker forward abreast of the 6-inch reserve magazine? Give the history of the coal inside.

A. That bunker was stored in either Newport News, Va., or at Norfolk. It contained soft coal; Pocahontas, I think. If it came from Norfolk, I inspected it. It was full of soft coal, about 40 tons.

Q. Were not the bunkers immediately abaft of it, B4 and B6, empty?

A. Yes, sir.

Q. The after bulkhead of A16 was easily accessible?

A. Yes, sir.

Q. What other sides were accessible to ascertain the temperature in case it should have been over hot?

A. You could feel it from the wing passage, and there was an escape door on platform deck A. There was a sign there, "Keep that door closed." That was on account of the opening into the passing room, the loading room.

Q. What was the condition of the after boilers—the two that were used for auxiliary purposes?

A. The fires were practically banked on the six furnaces of the two boilers. In what respect do you mean?

Q. The condition of the boilers.

A. The boilers were in good condition—in very good condition.

Q. You do not consider there was any danger of their having too much pressure on for safety when you were working them for auxiliary purposes on the evening of the explosion?

A. No, sir; the safety valves blow at about 130 pounds, and we usually carried 80 to 100 for auxiliary purposes.

Q. Where were you at the time of the explosion?

A. I was ashore.

Q. Did you have the usual thermostats in the bunkers?

A. Yes, sir; but they didn't work very well. Sometimes they rang when there was no coal in the bunker.

Q. I believe you never had a fire from spontaneous combustion in that ship, did you?

A. No, sir. We thought we did once, but it was a leaky steam-pipe—a leaky exhaust pipe from the ice machine.

Assistant Engineer John R. Morris, of the "Maine," was also called and questioned:

Q. You were on duty the day of the explosion?

A. Yes, sir.

Q. When did you inspect the bunkers on that day?

A. It was some time during the forenoon; I think between 10 and 11 o'clock.

Q. Can you remember distinctly making a careful inspection of bunker A16, the port forward bunker?

A. I remember of opening the escape doors, and there was no heat perceptible, more than just the temperature of the hydraulic room, which is next to the bunker.

Fireman William Gartzell, of the "Maine," testified that he was at the tiller room adjoining the storeroom and over a magazine when the explosion occurred. He described his experiences in a straightforward, interesting way:

Q. Tell the court exactly what you felt, and heard, and saw.

A. Just a second before that Rushford, chief machinist, came to me and asked me for the loan of the keys to go in the storeroom. He said he was restless and couldn't sleep. I gave him the keys and told him to put the keys near my shoes, that I was going to sleep there that night. I laid there. I had a book in my hand and was going to read. Gardiner was lying down beside of me. Just as soon as I laid down, I was talking to him and I hadn't spoke three words. He was telling me his time was out in May, and I said mine was out in June, and he made the remark that he was going to wait for me—all like that, just fooling, and just then a flash came. It was a blue flash. It seemed to me like it was right by the lamp in the engine room. I could see as plain as day.

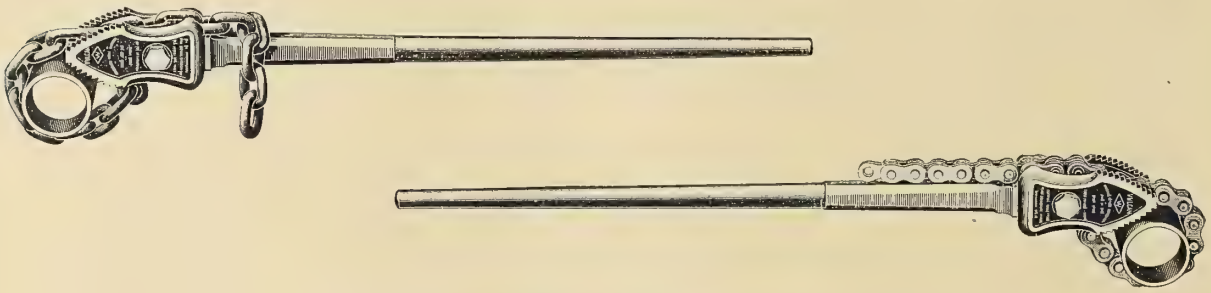
Q. How could you see into the engine room?

A. I could see through the door, sir. It was a kind of a blue flame, and it came all at once. The two of us jumped up, and I went on the port side up the engine-room ladder, and Frank Gardiner, he went up the starboard side—at least he didn't go up, because he hollered to me. He struck the door right there where the partition separates the two doors, and he must have struck his head. He hollored to me; he says: "O Jesus, Billy, I am gone." I didn't stop then, because the water was then up to my knees. I made a break as quick as I could up the ladder, and when I got up the ladder into the steerage room the ladder was gone. Everything was dark. I couldn't see nothing; everything was pitch dark, and I gave up, or I started to give up. There was a colored fellow with me; I didn't know his name until afterwards. His name was Harris. We got hold of each other. I says: "Let's give up; there is no hope." I started in to say a prayer the best I knew how, and I heard a voice. It must have been an officer; it couldn't have been a man's voice, because he says: "There is hope, men." I knew from that that he was an officer. After that I seen a little light. It looked like an awful distance from me, but I made for that light, and when I got there it seemed like I could see the heavens. It got jammed in the ladder. My head was right up against the deck. I seen the ladder, and I caught hold of Harris, and the two of us hugged each other.

IMPROVED APPARATUS.

Vulcan Drop Forged Chain Pipe Wrench.

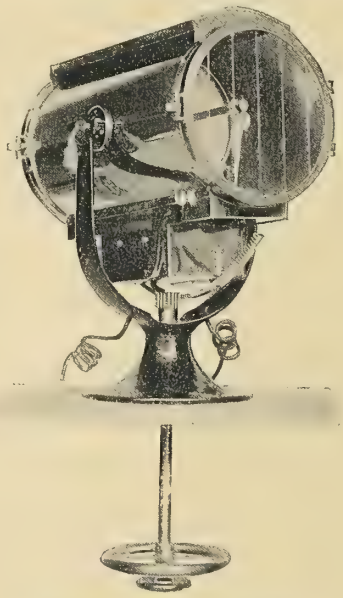
For gripping, turning, or holding pipe, bolts, bars, and shafts, from 1-8 in. to 12 in. dia., the Vulcan drop-forged chain pipe wrench is an exceedingly convenient tool. Either cable chain or flat link chain can be used with one wrench, the change being readily effected. The flat link chain is usually preferred for use in handling pipe, while the cable chain is used quite extensively when handling fittings. The drop-forged jaws are of saw temper, so that when dulled the teeth can be sharpened with a file. In working with this form of wrench the danger of crushing is obviated, as the pressure of the teeth is on a line tangent to the circumference of the pipe, and the encircling grip of chain distributes the power applied very evenly. It will be noticed that the chain swings from the center, and can be used on either side of the jaws, prolonging the life of the wrench as originally purchased. It is made on the interchangeable system, so that any portion can be purchased separately, and the wrench always kept in good condition. This tool is manufactured by J. H. Williams & Co., 31 Richards street, Brooklyn, N. Y.



VULCAN CHAIN PIPE WRENCHES WITH FLAT AND LINK CHAINS.

Carlisle & Finch 9-in Projector.

To meet the demand for a small, compact and moderate priced searchlight projector, the Carlisle & Finch Co. is now making a 9 inch lamp, as shown here, which embodies all the good points of the larger lamps. This lamp is made in Form "1" and "3" only. It consumes from 5 to 8 amperes of current, according to the resistance in circuit. It throws a very powerful light for so small a lamp, and it is possible to pick up buoys at 1-3 to 1-2 mile distance with it. All parts of the case and trimmings are well made and neatly finished. The case or cylinder is made of brass, highly polished, and the stand of iron or brass, as ordered. The illustration shows the Form "3" lamp. Form "1" is the same in every particular, except the pilot house steering gear is omitted. These lamps are fitted with silvered copper reflectors or with high grade glass lens mirrors, according to the wishes of the purchaser. The copper reflector used is a shallow parabola and throws a very good light. If desired the wires from lamp may be brought down and out through the base of the lamp. In this case they will come inside of pilot house alongside the steering tube. No sliding contacts are placed in the base of the 9 inch lamp, as there is not enough room to permit their use. The feeding of the carbons is produced by a magnetic trembler that is very accurate and positive. Lamps of this type are in extensive use on yachts and launches, and on Yukon River boats. The manufacturer's address is Cincinnati, Ohio.

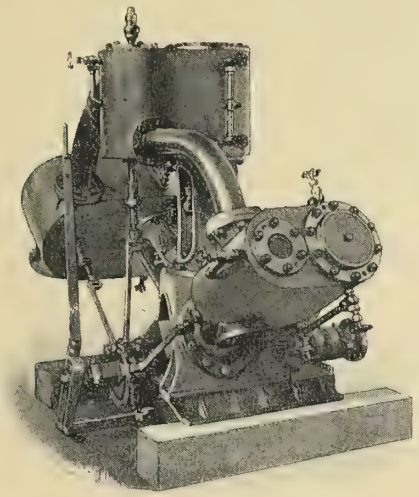


CARLISLE & FINCH PROJECTOR.

Yankee Twist Drill Grinder.

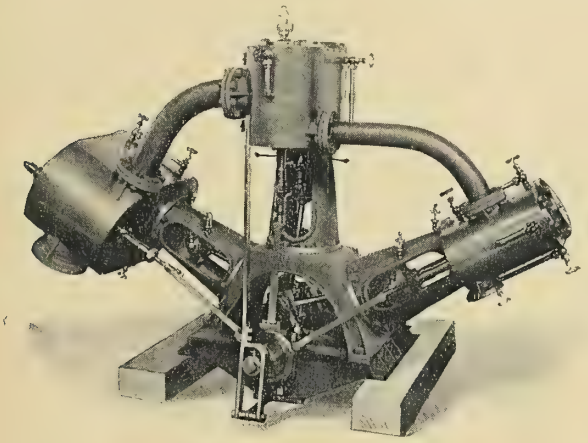
A compact workshop appliance is here shown in the cut of the Yankee Twist Drill Grinder, which contains many points of excellence. The machine illustrated occupies only 1 1-2 ft. by 3 ft. floor space and is 4 ft. high, and weighs 225 lbs. It will accurately grind any size of drill from 1-8 in. up to 2 1-4 in. dia. and can also be used for grinding flat drills and chucking ream-

ers. The drills are laid in V blocks, which are moved laterally only during the grinding process, so that the drills are centered true and both lips



WARD TRIPLE-EXPANSION ENGINE.

ground geometrically alike. Any desired clearance can be given, the drill being ground by a slight thumb screw adjustment. In construction the machine is well adapted for the work. The bearings on the grinding wheel spindle are

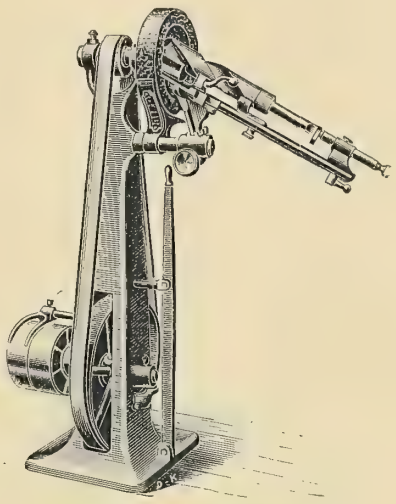


WARD TRIPLE-EXPANSION ENGINE.

long, the pulley surfaces are large, and there is protection at the oil holes to exclude grindings from the bearings. The machine is manufactured by the G. T. Eames Co., Kalamazoo, Mich.

Ward Triple-Expansion Marine Engine.

We here present two views of a novel triple-expansion marine engine, having only one crank and one eccentric, which was designed and built by the Ward Engineering Wks. of Charleston, W. Va., the manufacturers of the Ward water tube marine boilers. It will be seen that, instead of arranging the cylinders as usual, in a line above a three-throw crank shaft, they are placed radially with the shaft and connected to a single crank. The intermediate cylinder is placed vertically and midway between the high and low pressure cylinders, which are at an angle of 60 degrees on either side. This arrangement disposes the power on the single crank at three equal points of the circle, producing the same result as the ordinary triple, having three cranks arranged at 120 degrees with each other. The valve gear is exceedingly simple, consisting of a single eccentric, which is moved from the go-ahead position to astern, by travel across the shaft, produced by a sliding wedge moving in an angular channel in the body of the eccentric. The valve rod of the center cylinder is secured fast to the eccentric strap, while those of the two outside cylinders are pivoted. It is obvious



YANKEE TWIST DRILL GRINDER.

the three cylinders being radial with the shaft that the eccentric controls the valves of all three cylinders alike and in proper sequence; so when the eccentric is moved across the shaft by the hand lever the engine is linked up, reversed, or thrown on the center at the pleasure of the operator. The engine is fitted with piston valves throughout, and also with thrust bearings. While the cylinders show considerable spread athwartship the length occupied is about one-third that of an engine of like power, having three cranks and the usual link motion: thus saving an equivalent length of ship or boat and a large amount of mechanism, viz., two main cranks, two main bearings, five eccentrics, three link motions. Gains are thus effected in weight, first cost, friction and maintenance, while the running qualities are improved and the vibration reduced to the minimum. The engine illustrated has cylinders 7 in, 10 1-2 in. and 16 in. dia. and 10 in. stroke, and is designed for 200 lbs. steam pressure and 500 revolutions.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.

S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representatives.

L. L. CLINE, Detroit, Mich., 47 Hodges Building.
B. M. GARDNER, Chicago, Ill., 1522 Monadnock Block.

Traveling Representatives.

E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

LET the text books on naval operations be burned. Manila and now Santiago have shown, simply, that in the destructive as in the constructive arts America can depart from the orthodox and be easily successful. Prior to these demonstrations of our naval efficiency had any student or authority, in matters naval, declared that five cruisers and three gunboats could be turned into scrap without the loss of a man (as at Manilla), or that four magnificent cruisers and two up-to-date destroyers could be shattered, and sunk, with only the loss of one man killed and two wounded, as a list of casualties at Santiago shows, he now would be the inmate of a padded cell. The higher his attainments the sadder would be the expression of his friends who might exclaim: "Poor fellow, how sad to see such a brilliant mind give way." The American Civil War evolved the ironclad, and gave the torpedo a standing in tactics, thus changing the complexion of the fleets of every navy. The Spanish-American war has already pointed new ways, not so much in construction, perhaps, as in operation. It is not ended yet, and, at its close, there will probably be also a change in constructive policy in naval circles, as a result of the Santiago fight. What problems in construction need further solution cannot yet be clearly stated, for the reason that accurate technical details of the damage caused by our fire are so far not obtainable. Some of the enemy's vessels are submerged and those still above water have not been exhaustively reported upon. On our ships, little could be learned regarding details of construction or equipment to be avoided or changed, for they were not put to any severe test by the Spanish fire. There was opportunity, of course, to decide, by practical experience in action what additions might be made in the various apparatus in the machinery or batteries, to render our ships more effective offensively. A fact which the details already made known clearly emphasizes however, is that the modern warship is a floating machine ship. There is not only the extensive installation of main engines and boilers, with their numerous auxiliaries, needing attention, but the equally important machinery used in manipulating the guns and in getting the ammunition to the guns. It was all round efficiency rather than any brilliant feats of leadership which gained the glorious victory at Santiago. This is what gives comic-opera flavor to the dispute—started no one knows how—as to whether Commodore Schley or Rear-Admiral Sampson is entitled to the credit. From the moment the Spanish vessels were sighted coming out of the harbor, until the Colon helplessly touched bottom, it was a fight of ships and components of ships rather than a fleet action. The words of Wellington: "Up Guards and at 'em," best describe the occasion. When the warning signal was given general quarters found every man in place. Our vessels were at a disadvantage in that full steam was not, of course, on the boilers. But no words of encouragement to the crew down below were needed when the captains rang for full-speed ahead. The engineer forces could have given pointers to trial trip experts. Fires were stirred and coal heaved into the furnaces by the ton, draft fans started, and in the engine rooms, throttles opened and the links put into full gear ahead; then, watching feed, lubrication, and the condensers, the engineering staffs could only trust in fate that no shell would burst a steam pipe, and so turn engine room and stokehold into a rendering tank in a slaughter-house. Above decks the only navigation needed was to keep each ship on her course, and other than this to load and fire as fast as ammunition could be brought up, and as often as the gun sights bore on the enemy's ships. To the Captain of each ship belongs the credit of having kept up to the highest notch of efficiency his vessel and crew.

THE loss of the S.S. La Bourgogne is additional evidence that in a collision the vessel striking end on has a far better chance of surviving than the vessel which is struck broadside. There are notable exceptions to this, the most recent which occurs to us being the collision between the U. S. cruiser Columbia and the freight steamer Foscolia, off Fire Island, in May. It is not infrequent for vessels to reach port with bows crushed in and forward compartments full. The ramming of an iceberg by the Guion liner Arizona (now a U. S. transport on the Pacific coast) will be recollected as a severe test. A remarkable case of midship damage which did not result in the loss of the vessel was the accident to the Inman liner City of Paris (now the Yale of our Navy). The smashup of her starboard engine carried away the sea connections and flooded both engine compartments. Experience has proven that there is no form of construction that is absolutely safe under all conditions of disaster; and theoretically such a design would be impossible, involving physical contradictions. It has been shown, however, that even in extreme cases the safety of the vessel is assured by modern methods of construction; and in nearly all, with prompt and intelligent handling, the sinking of a vessel may be so delayed that those on board can get away in safety. No inanimate apparatus, however, can replace the workings of human intelligence and bravery in time of great peril, and this brings us back to the La Bourgogne disaster. According to the more trustworthy reports of survivors panic took hold of those in authority, and, naturally, the demoralization of subordinates and passengers followed. Brute strength and self-preservation were rampant. In discipline could lie the only salvation for all on board, and when the officers resigned the management of the ship in favor of ignorant and cowardly firemen and so-called sailors, the fate of those on board was settled. On English-speaking liners it is customary for the captain to retain command of his vessel in emergencies, and he has the co-operation of a set of officers who are prepared to obey. Duty and a heavy navy revolver enforce all commands, and an instant's violent disobedience means death from other causes than drowning. "Women and children first" has ever been the watchword on these transatlantic liners. When the smashup on the Paris occurred the Chief Engineer and members of his staff went into the engine room, in black darkness, amid a horrible tangle of broken machinery, with the ship rolling each way over 20 degrees, in an effort to close the sea connections. Not until the inrushing water had reached up to their heads did they retreat, and then only to labor with desperate energy shoring up the adjoining bulkheads. With 3,000 tons of water inside, the ship was thus kept afloat and reached port in safety. In such lines the traveling public may well have confidence, for, better than all bulkheads and water-tight doors, there are men in command.

A CHARACTERISTIC feature of the work of our vessels in the recent naval operations is the dare-devil spirit so often displayed. At the commencement, we have the entrance of Admiral Dewey's squadron into Manila harbor in spite of all torpedoes reported and actual. Then Naval Constructor Hobson takes the collier Merrimac under the fire of the coast guns at Santiago in as deliberate a fashion as though going ashore in a friendly harbor. Next a transatlantic liner, the St. Louis, tackles a thirty-knot destroyer, the Terror, at San Juan and sends her back to shelter disabled and impotent for evil. And in the battle at Santiago Lieutenant Commander Wainwright crowds on all steam on a pleasure yacht, armed only with 6-pounders, and gives battle to two thirty-knot destroyers, with crushing effect. In addition to these remarkable episodes there are, almost, daily reports of heroic deeds, the moral effect of which will be felt for generations.

SOME time ago, in the course of an editorial about defects in British built vessels, we referred to a cable message from Valparaiso, which was very widely published in this country. The message stated that a torpedo-boat destroyer built in England for the Chilian Government was found to be so defective in construction as to be absolutely worthless. We have received a communication from a representative of Messrs. Laird Bros., of Birkenhead-on-the-Mersey, in which that firm makes this statement:

"We have built the only torpedo-boat destroyers that Chili has got, and every one of the reports that we have received, even up to to-day, go to show what complete satisfaction they have given since they left our works."

Our informant adds that the Laird Bros. have completed and passed through their trials considerably more than a dozen 30-knot destroyers.

MISHAPS AT SEA.

LOSS OF THE FRENCH LINER LA BOURGOGNE WITH 550 LIVES.

One of the most fatal and probably the most horrible mishaps in the passenger trade on the Western ocean occurred July 4, when the French liner La Bourgogne was ran into and sunk by the British sailing ship Cromartyshire and more than 550 passengers and crew of the liner were drowned. The collision occurred in a dense fog about 60 miles south of Sable Island. Between the time the blow was delivered and the liner disappeared below the water only a few brief minutes elapsed, but during this time there occurred scenes of cowardice and crime which could only find parallel among the most depraved of savage tribes. To this entire absence of discipline or co-operation among those on board the awful loss of life was apparently largely due. The vessel had nearly 800 persons on board, of whom about 165 were saved and of these only one was a woman.

Shortly before 5 o'clock on the morning of July 4 Captain Oscar Henderson of the Cromartyshire while in his chart room heard a steamer's whistle. His ship was moving at about four knots speed with the fog horn sounding. He was unable to locate the direction of the siren, and an instant or so later his ship rammed the La Bourgogne on the starboard side about amidships. The adjacent compartments of the liner filled immediately, changing her trim so that the decks were at a steep angle to starboard. The blow had smashed some of her boats on the starboard side, and the inclination of the ship made the handling of boats on the port side a difficult matter, even if any organized effort had been made to launch them. From the testimony of passengers who were saved a horrible scene of confusion followed the collision on the liner. Most of the passengers were in their berths at the time and they rushed out, wildly excited, as persons who were awakened from a sound sleep, in unfamiliar surroundings, to meet probable death might be supposed to become. Passengers who were saved say that among those who reached the boat deck—principally sailors and steerage passengers bound for Austrian and Italian points—desperate fights occurred for places in the few boats which were launched. Knives were freely used, and the time wasted in these cowardly combats accounts for the failure to get afloat some of the rafts carried, or to make emergency preparations for saving life. In her condition of instability the ship was a difficult place to even walk on, and the inrush of water speedily destroyed her buoyancy and she sank. Some of the boats which had been gotten out were swamped, and many passengers afloat were carried down in the final plunge and suffocated. Many who were afloat, clinging to wreckage, tried to get into the boats and rafts which had been safely launched or on the floating wreckage, but they were, in many instances, beaten back and drowned. Among all these brutish scenes the conduct of some ministers of religion was conspicuously noble. They went among the terrified passengers, saying words of comfort as long as the ship remained afloat, and thus, neglecting their own safety, they perished.

Some of the cabin passengers succeeded in getting into boats, but there was apparently no effort made to get these boats into the water, and the occupants were carried down with the vessel. One of the boats so filled is said to have been smashed to pieces by one of the funnels which fell on top of it.

Meanwhile the Cromartyshire had drifted away with her forward compartment full, but her bulkheads were staunch and some of the cargo was jettisoned so as to improve her trim. About half an hour after the collision a boat filled with sailors from the liner came alongside and told Captain Henderson of the disaster. The boats of the sailing ship were immediately put out and her crew rescued many of those from the liner who had kept themselves afloat.

Not a single officer of the La Bourgogne was saved, and for this reason, and because of the secrecy imposed by the French line on the members of the crew saved, no clear technical account of the mishap could be had. The members of the crew were brought to New York and sent home on another of the French liners. Three boats got away from the liner and reached the Cromartyshire safely. The first boat contained sailors in a majority, if not exclusively, and the other two also contained many of the crew of the liner. In all, out of the 160 odd persons saved, only about fifty were passengers and the remainder members of the liner's crew.

About three hours after the collision the Allan liner S. S. Grecian was sighted and took the Cromartyshire in tow, reaching Halifax, N. S., July 6.

In the engraving which we here print the S. S. La Bourgogne is shown as she formerly appeared with four masts. At the time of the mishap she had only two masts and no yards, for the main and mizzen masts had been removed when the vessel was overhauled last year. New machinery was then fitted in her and many additional conveniences for ocean travelers supplied. She was built at the Forges et Chantiers, La Seyne, France, of steel, in 1886. Her general dimensions were: Length over all, 494.5 ft.; load water line, 480 ft.; beam, 52.3 ft.; depth from main deck, 34.4 ft.; tonnage, net 2,985; gross, 7,395; displacement, 9,925 tons at 24 ft. draught. She was fitted with ten bulkheads in accordance with Bureau Veritas rules and United States regulations for a vessel of this class. She had accommodations for 1,236 passengers and crew. About 600 could be carried in the steerage and 400 in the first and second cabins. The crew, officers and men, numbered about 220. There were twelve large boats and four life rafts on the ship.

When built she was fitted with compound engines driving a single four-bladed screw 21 ft. dia. Last year when she was altered new engines and boilers built at St. Nazaire were fitted. The new engines were triple-expansion with cylinders 42 in., 44 1-8 in. and 79 in. dia. and 67 1-2 in. stroke. There were twelve single-ended Scotch boilers 9 1-2 ft. long by 15 1-4 ft. dia., each fitted with three 36 in. furnaces. The working pressure was 160 lbs. She had a sea speed of about 18 knots.

The Compagnie Generale Transatlantique, owner of the La Bourgogne, has been singularly unfortunate in respect to marine mishaps and disasters. Serious accidents to machinery, causing delays and anxiety, have been frequent, and disasters attended with loss of life not uncommon. In March, 1897, the S. S. Ville St. Nazaire, belonging to the company and trading between New York and the West Indies, foundered in a severe storm off the Virginia coast. In attempting to lower boats many lives were lost, as the heavy seas dashed the boats to pieces against the ship's side. In one boat thirty-five persons got away safely, but of those only seven were alive—mostly insane—when the boat was picked up at sea seven days later by the schooner Hilda, of Perth Amboy. Another boat load was rescued by an ocean steamer on its way to Europe.

Another awful disaster in the history of the company was the loss of the liner Ville du Havre, which was sunk in collision with the sailing ship Loch Earn in latitude 47 N., longitude 35 W., on November 22, 1873. There were 313 persons on the liner, and of these only 87 were saved, including 33 first-class passengers, 10 of whom were ladies, 29 firemen and boys, and 25 of the crew, including the captain and five of his officers. The night was clear and

both vessels had proper lights burning, and there was a heavy sea with but little wind. The sailing ship struck the steamer amidships and tore an enormous hole in her side. In less than fifteen minutes the Ville du Havre filled and went down head first. After the collision, according to the testimony of survivors, there was an entire absence of concerted effort to save anyone. Sailors and coal passers made a desperate rush for the boats. The long boat was launched, only to be smashed by the main mast, which fell and killed most of those in the boat, including a number of steerage passengers. Only a whaleboat and the captain's gig were launched before the vessel went down. Boats were lowered from the Loch Earn and many in the water were rescued. Among those who were lost were Judge Rufus W. Peckham, of Albany, N. Y., and his wife. Some of the survivors recalled having seen him standing beside his wife on deck, encouraging those around him and saying, "If we must go down let us do so bravely." In this way, with as much exterior calmness as though delivering a verdict on the bench, he waited for death. The Loch Earn was badly damaged by the collision but kept afloat. She spoke the American ship Trimountain next day, and on account of her leaky condition transferred her passengers to the American ship. The Loch Earn was a Glasgow vessel of about 1,200 tons.

The Ville du Havre was, for her time, a fine vessel. She was built of iron at the Thames Iron Works in 1866 as a side-wheel steamer, and early in the seventies she was thoroughly overhauled. The hull was lengthened and she was fitted with compound engines and a single screw. Her dimensions were: Length, 423 ft. 6 in.; beam, 43 ft., and depth, 33 ft. 7 in. Her gross tonnage was 5,000 tons. She was valued at $1,500,000 and carried a cargo worth $300,000. M. Surmont, the commodore of the line, was in command of her when she was lost.

Burning of Clyde Liner Delaware.

Fire destroyed the Clyde line steamship Delaware while on a trip from New York to Charleston on the night of July 8. During the afternoon she left her pier in the North River with a full cargo and 32 passengers, of whom nine were women and three children. About 9.20 o'clock at night one of the crew reported that there was a fire in the after hold. Captain A. D. Ingram and his officers and crew began a thoroughly organized effort to save the ship and provide for the safety of the passengers. The fire pumps were, of course, started and several streams of water directed into the hold. Meanwhile the officers, assisted by Stewardess Ellen C. Hill, notified the passengers to be prepared to take to the boats. Some of the passengers were inclined to be hysterical, but the self-possession of the officers calmed them and the preparations went on uninterruptedly.

As the vessel was built of wood, the fire found

FRENCH LINE S.S. LA BOURGOGNE AS SHE APPEARED IN HER ORIGINAL RIG.

ample material to feed on besides the cargo, and Captain Ingram, seeing that there was no chance to save his ship, headed her toward the shore, the Delaware being then in the vicinity of Barnegat, on the Jersey coast. Fortunately the sea was calm, and when the fire had reached the upper deck the order was given to lower the boats. Women and children first, then passengers, crew and officers, and finally the Captain, in an orderly manner, got into the boats and on the life rafts, and kept together in the vicinity of the vessel, that now served as a signal for assistance. A life boat from the shore reached the Delaware shortly after. The passengers were finally taken back to New York on a tug which was bound out with a tow when the blazing vessel was sighted.

Few of the crew were without severe burns received in fighting the fire, and many brave acts occurred before the vessel was abandoned. Chief Engineer Clayton Platt, when the fire had reached the machinery spaces, groped his way to the boiler room and released the safety valves to prevent the possibility of an explosion. Both engineers and firemen remained at work until the smoke became so dense that they were in danger of suffocation.

The Delaware was a wooden steamer, built at Hillman's yard in Philadelphia nearly twenty years ago. She was 250 ft. long, 37 ft. beam, and 17 ft. 8 in. deep. Her gross tonnage was 1,646 tons. The cargo consisted chiefly of provisions, dry goods and saltpetre, and with the ship was worth about $230,000.

CORRESPONDENCE.

Concerning Specifications for U. S. Destroyers.

The circular for destroyers and torpedo boats in your June number invites a criticism, and as similar clauses have occurred in previous circulars for boats of this class, I take this opportunity to call attention to them.

The requirement for bunker capacity and for coal carried on trial, both in the case of destroyers and boats, should be stated as coal to steam a given distance at a given speed and not as a fixed weight.

The reason for this is from the fact that, while two boats may be of exactly the same size, one of them may take 50 per cent. more coal than the other to go the same distance, owing to the wastefulness of her machinery.

The economical boat is manifestly much more advantageous to the Government, and some inducement ought to be offered to the builder to get economy of coal.

If the circular read, "total bunker capacity must be supplied for coal enough to enable the boat to steam 3,000 miles at 14 knots," and in the list of trial weights "enough coal in the bunkers at the beginning of the trial to steam 1,000 miles at 14 knots," this desired economy could be had. This coal could be determined from a previous trial at 14 knots on which the consumption of coal is accurately measured.

The above system would offer an inducement to the builder to furnish economical machinery, because he could see a way of reducing his load carried on the full speed trial, and hence he stands a better chance of getting his guaranteed speed. On the contrary, if his machinery proved wasteful, he would have to carry an extra load on trial.

A Subscriber.

In awarding contracts for the new battleships the Navy Department will give special consideration to speed and coal endurance. A circular to be issued will advise bidders of this, and will place the steaming radius of the battleships at 5,432 knots at 10 knots speed.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—XI.

BY WM. BAXTER, JR.

To give an idea of the appearance of machines in actual use, the construction of which was diagrammatically represented in Fig. 49, two machines are here

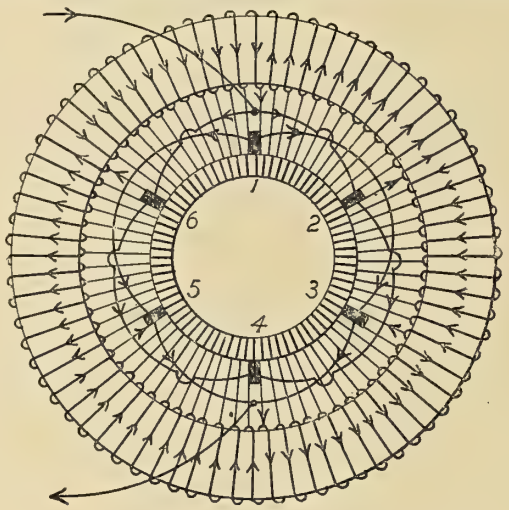


Fig. 57.

shown. Fig. 55 is arranged to be belt driven, a form that still finds favor on some ships, though it has been to a great extent displaced by the direct connected set. A direct-connected engine and four-pole generator representing the latter form is shown in Fig. 56.

The manner in which the armatures of multipolar machines are wound is substantially the same as in the two-pole type, but that which corresponds to the drum winding of the latter, appears to be very differ-

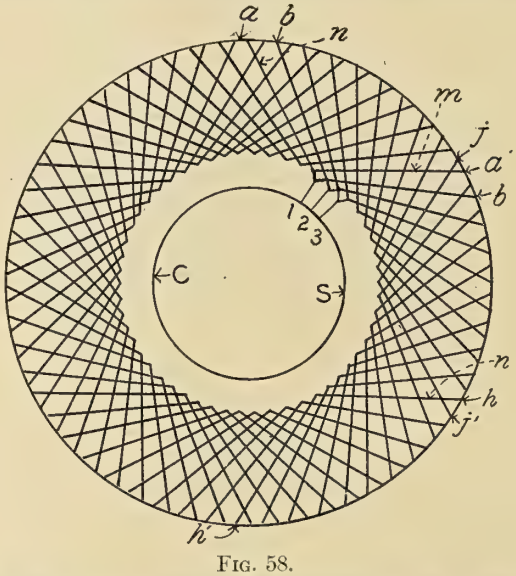


Fig. 58.

ent. The ring winding is identical, as can be seen from Fig. 57, but the manner in which the coils are connected with the commutator is not the same, except for what is known as the parallel con ection, which is the kind shown in this figure. The direction of the current through the various coils, as well as

through the wires leading to the brushes, is indicated by the arrow heads. It will be noticed that the current coming in at the top divides into two branches and passes to the brushes located at the upper corners, and from these proceeds to the lower centre brush. The current from these three brushes passes into the armature coils, and after going through one-

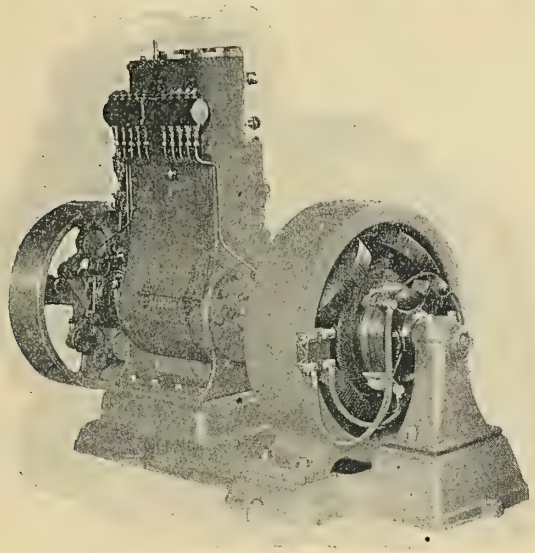


Fig. 56.

sixth of the number of coils on either side passes out to the intermediate brushes and thus to the lower wire. With the simple two-pole ring winding it will be remembered that the current divides on entering the armature from the commutator brush, one-half passing through each path, and unites again at the other brush, each current traversing one-half

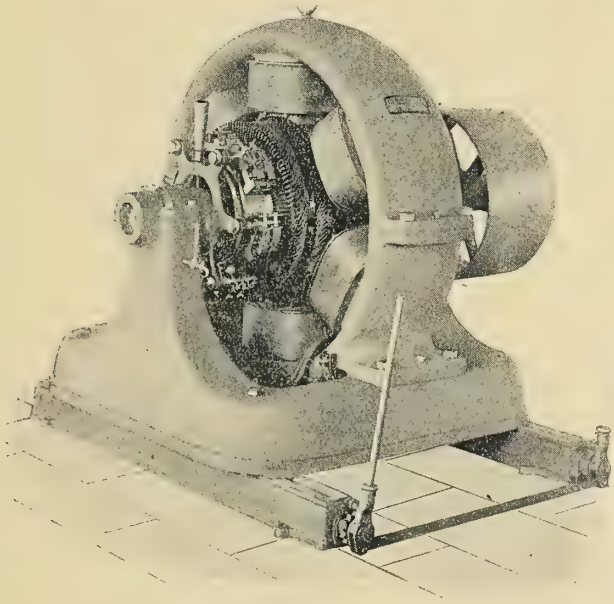


Fig. 55.

of the armature circumference. Considering this we see that if the armature rotates in a two-pole field and the commutator is provided with two brushes, each current will pass through coils covering one-half the circumference. From this we would at once infer that if the machine has four poles, and four commutator brushes, each current would only pass around one-quarter of the circumference before reaching the other brush, and this is strictly correct. If the machine has six poles each current will pass around one-sixth of the circumference, and for ten poles around one-tenth of the circumference, and so on in proportion. A little reflection on this point will show that an armature wound in the manner required for a two-pole ring winding will run equally well in a field of any number of poles providing as many brushes are placed upon the commutator as there are poles, and that the alternate ones are all connected with each other. Under these conditions the voltage between the adjoining brushes will be reduced directly in proportion to their number, that is, if there are four brushes the voltage will be half as great as if there are two, and with eight brushes one-fourth as great. At the same time, since the wire is not changed, and there are in the four-pole machine twice as many currents, and in the eight-pole machine four times as many, the strength of the current in one case will be twice as great, and in the other four times as great. If we desire to keep the voltage at the same point we can accomplish the result by so connecting the armature coils that the voltage of one section is added to that of the others. This is what is called series connection. To connect a ring wound armature in this manner it is necessary that the ends of the coils be connected, not with the adjoining one, but with the end of a coil occupying the same relative position in the next adjoining magnetic circuit. To illustrate, suppose we take the first coil to the right of the upper brush in Fig. 57, in the figure one of its ends connects with the coil to the left of it and the other end with the coil to the right. Now to connect the coils in series, one end of this coil would have to be connected with the opposite end of first coil ahead of brush 3 and the other end of this coil would be connected with the coil ahead of brush 5. The end of this last coil would be carried to the coil back of, or ahead of the coil from which we started. From this it will be seen that the difference between parallel and series winding is that in the latter the first coil to the right of brush 1 connects with the first coil to the right of brush 3 and thence with the first coil to the right of brush 5, thus making a complete circuit of the armature, and from this point the connection goes to the coil next to the one from which we started. The end of the second coil must then connect with the second coil ahead of brush 3, and the end of this with the second coil ahead of brush 5, before we can connect with the third coil ahead of brush 1. If a diagram is drawn in which all the front ends of the coils pass directly to the commutator segments, and the other ends are carried around and are connected with the segment to which corresponding coils are connected, the connection will be correct for a series winding. To make the connections symmetrical, however, it is necessary that the number of coils be such that it must be increased or decreased by one to be divisible without a remainder by half the number of poles. We will not go more fully into an explanation of this part of the subject, at the present time, as it will be treated at length in a future article.

The drum winding of multipolar armatures is called "formed" coil winding, or simply coil winding. It receives this name from the fact that the coils are not wound in place, as is the case with ring winding, or to pole drum winding, but are made on forms and are then assembled in their completed form upon the armature core. In two-pole drum winding, it will be remembered that the wire is carried across to the opposite side of the diameter, this being necessary so as not to have both sides of the coil opposite poles of the same polarity. In a multipolar machine, however, the adjoining poles are of opposite polarity, hence, it is only necessary to carry the coil as far around the circle as the next pole. Fig. 58 will serve

to give a general idea of the manner in which formed coils are placed upon an armature and their connection with the commutator. The figure represents a six-pole winding. The lines *a a'* which represent the two sides of one coil are one-sixth of the circumference apart, and, as will be seen, if we were to wind the wire in a straight line from one to the other it would come so near to the edge of the core that before many coils had been put on there would be no room left for the succeeding ones. In order to make room, therefore, it is necessary to run the wire down toward the center as indicated by the lines *n m*. Now if the part *n* of the coil *a* is placed close to the surface of the core, and the part *m* is, say, one-quarter of an inch further from the surface than the space occupied by *n*, then the part *n* of all the coils will pass freely under the part *m* and the coils will fit into each other without crowding at the ends. At both ends of the armature the coils are made of the same shape, so that the lines *n* and *m* can be regarded as covering similar lines at the pulley end, the part shown being the commutator end.

If a coil-wound armature is connected with the commutator in parallel it is said to have a lap winding, and if in series, a wave winding. Why these

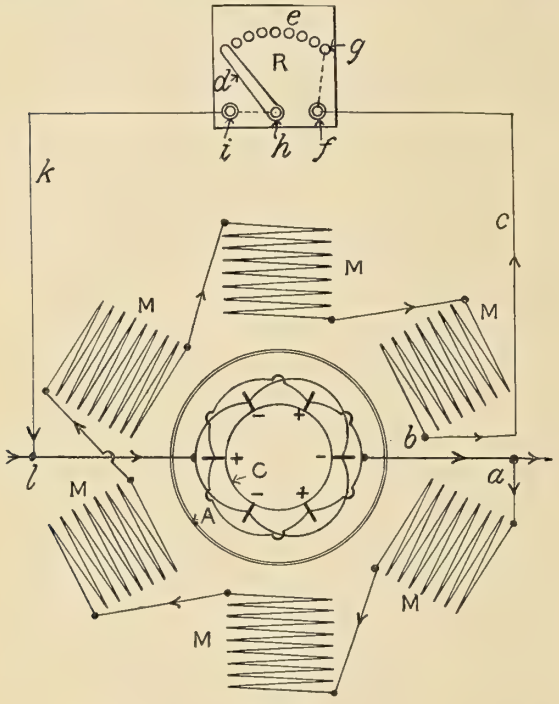


Fig. 59.

names are given will be understood from the following explanation of the connections: Let *a a'* and *b b'* be the two sides of adjoining coils, then if the connection is in parallel, the end of *a* coming from the *n* side will be joined to the end of *b* coming from the *m* side, the two ends being carried to the commutator segment marked 1. Then the end of the *b* coil coming from the *n* side will be connected with the end of *c* coil coming from the *m* side and these two ends will be carried to the commutator segment 2. By examining this method of connection it will be seen that coil *b* laps onto coil *a* and *c* onto coil *b*, and the same order will be maintained all the way around the armature, hence, the term lap winding. If the armature is to be connected in series, the end of coil *a* coming from the *m* side will not be connected with the adjoining coil, but will be carried to a commutator segment located at *s*, and to this same segment will be connected the end of coil *h* coming from the *n* side. The end of *h* coming from the *m* side will be carried to a commutator segment one-third of the circumference ahead of *s* and to this latter segment will be attached an *n* end of the coil whose *m* end will connect with commutator segment 2. From this it will be seen that the connection progresses forward all the time in a series, or wave, that is, the appearance of the coils and their connections upon the diagram is a wave line.

A ring-wound armature, if in parallel connection, can be used in a field of any number of poles and will be as accurately connected for one as for another, but with a parallel coil-wound armature this is not true, except in a limited sense. If the armature is wound and connected for six poles, it can be used for four or even two poles, but it will not do as much work in either of these fields because part of the wire will act against another part. In a two-pole field the capacity of the armature will be one-third of what it is in a six-pole field.

A parallel connected armature, whether the winding is ring or coil, must have as many brushes on the commutator as there are poles, unless the commutator is cross connected, which is seldom the case, but if the connection is in series, two brushes will be

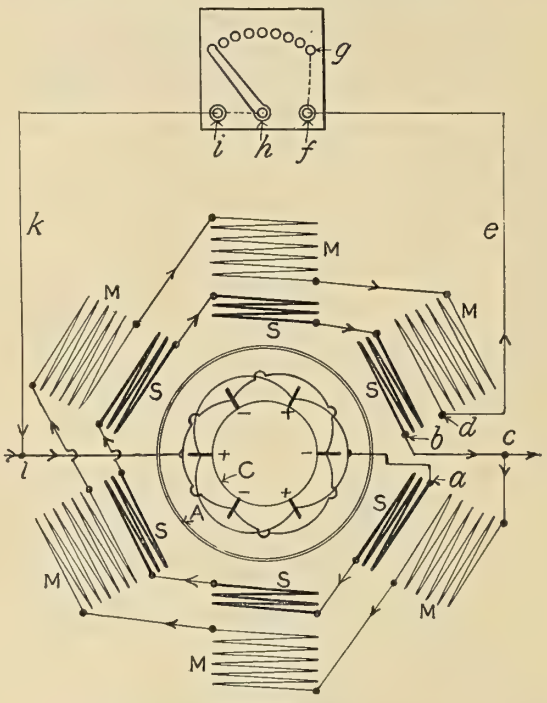


Fig. 60.

sufficient for any number of poles, although the number of brushes can be made anything from two up to the full number of poles.

The field coils of multipolar machines are wound in the same way as those of the two-pole type that is, in shunt, in series or compound. Very few multipolar machines with series-wound fields are used, in almost every case the winding is shunt or compound. Fig. 59 illustrates a shunt winding for a six-pole generator, and Fig. 60 a compound winding for a similar machine. As will be seen, in the shunt winding the current derived from the armature circuit at *a* passes through all the field coils in succession, and from the end *b*, goes by wire *c* to one of the binding posts of a regulating resistance *R*, commonly called a rheostat. In this rheostat, the post *f* is connected with the contact *g*, which is the last of the series of contacts *e*. The switch lever *d* connects with the wire *k* through *h* and *i*. The con-

tacts *e* are connected with each other by means of a considerable length of wire so that when the lever *d* is in the position shown, the current has to pass through several lengths of wire before reaching *k*; but if *d* is moved around toward *g* the number of these lengths will be reduced, all being cut out of the circuit when *d* rests upon *g*. When *d* is in the position shown the current passing through the field coils will be the smallest, because it not only has to force its way through the coils, but also through the resistance of the wire between the contacts *e*, and when it is moved over until it rests upon *g* the current is the strongest, for then it has only the resistance of the field coils to overcome. By placing *d* at intermediate points between the ends of the contacts *e*, different strengths of field current can be obtained.

In Fig. 60 the current for the shunt coils *M* is drawn from the armature circuit at *c*, but it can also be drawn from *a*. When drawn from *c* the arrangement is called a long shunt, and if from *a*, a short shunt. The full armature current passes through all the series coils *S* before reaching the point *c*. The regulating rheostat is placed in the shunt coil circuit. Both these windings it will be seen are the same as for the two-pole machines, and the regulating rheostat, which was not explained in connection with the latter type, is used in the same manner in both, its object being to change the strength of the shunt-coil current, and thus the strength of the field and the voltage of the machine.

ENGINEERS' DICTIONARY—VIII.

Boss or *Hub (of a propeller)*.—The central body of the propeller which supports the blades and communicates the motion to them from the shaft to which it is attached. The same term is often used more generally and more vaguely for any rounded-out portion of a structure through which a hole or a shaft is passed.

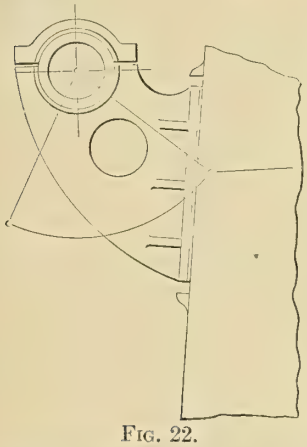


Fig. 22.

Bracket or *Bracket Bearing*.—A form of bearing supported by a projecting arm or bracket, as illustrated in Fig. 22, showing the support of a reversing or weigh shaft. The stern *shaft brackets*, for twin screws are arranged as illustrated in Fig. 23. These are also called *A frames* at times. The term *bracket* is also used signifying a brace in the angle of a casting.

Brine.—Sea water more or less concentrated as in a boiler by the evaporation of the water and accumulation of the salts. Ordinary sea water holds in solution about 1 part in 32 of solid matter consisting mostly of common salt. Water in boilers may become concentrated to a point where the solid matter reaches from 3 to 5 parts in 32. In engines with jet condensers the density of the water is a matter of constant observation.

Brine-cock.—See *Bottom-blow*. Used also in reference to a cock or valve used to draw water from the boiler for the purpose of testing by a *hydrometer* the amount of solid matter, or "*saturation*," as it is frequently termed. The more correct name for the latter is *salinometer cock or valve*.

Brine-pump.—A pump sometimes used to withdraw a part of the water in a boiler in order to prevent an excessive rise in the *saturation*.

Bronze.—A general term for alloys of *copper* and *tin*, or of *copper*, *tin* and *zinc* in varying proportions, and in some cases combined with other materials or subjected to special treatment giving special alloys

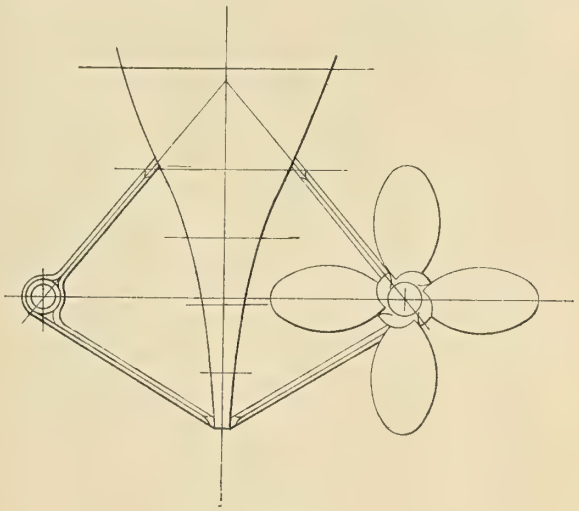


Fig. 23.

such as *manganese bronze*, *phosphor bronze*, *deoxidized bronze*, etc. The bronzes are in general harder, stronger and stiffer than brass. The strongest copper-tin or bell metal alloy is in the proportions of about 83 per cent. copper and 17 per cent. tin, its strength being about 33,000 lbs. per sq. in. of section. The strongest copper-tin-zinc alloy is in the proportions of 55 per cent. copper, 5 per cent. tin and 44.5 per cent. zinc, its strength reaching about 60,000 lbs. per sq. in. of section. For particular purposes, however, various other proportions of these constituents are used. The strength of the special bronzes approaches closely to that of cast steel, ranging, as it does, from 50,000 to 65,000 lbs. per sq. in. of section.

Bucket.—(1) Sometimes used in speaking of the *floats* of a paddle wheel. (2) Used in referring to a vertical pump piston fitted with valves opening upward. The latter are also known as *bucket valves*. See *air-pump*.

Bunker.—A compartment for the stowage of coal. From 42 to 44 cu. ft. are allowed per ton of 2,240 lbs.

Bush or Bushing.—A cylindrical lining used to reduce the size of a hole worn too large, or an accurately bored lining fitted to a hole for bearing purposes.

Butt-Joint of Seam.—A form of riveted joint in which the plates are placed with the edges together,

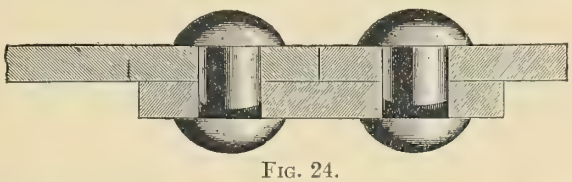


Fig. 24.

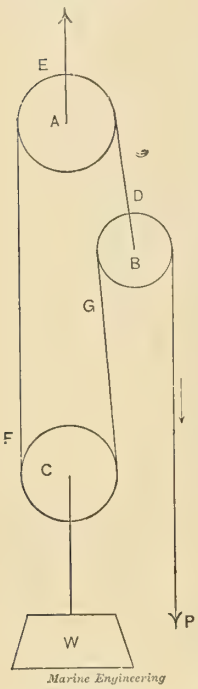
as in Fig. 24, and are joined by means of one or two *cover plates* or *butt straps*.

Butt-weld.—A form of weld for plates or bars in which the pieces are joined together with little or no *scarf*, and by pressure on the edges or ends.

By-pass.—A valve and passage allowing the flow of steam or water past or around, instead of through, an engine, pump, stop valve, or other mechanism. See also under *Bleeder*.

QUERIES AND ANSWERS.

Q.—What is the value of the purchase shown in the sketch; that is, if a man can pull 100 lbs., what can he lift with the purchase? We have had a big discussion over the question and can't agree, and an answer in your columns would be highly appreciated? FIFE-RAIL.



Marine Engineering

A.—The purchase in your sketch, and from which the figure has been drawn, is a well-known and ancient gag or catch, especially among officers of the navy. In appearance it somewhat resembles a Spanish burton, and without careful attention is apt to deceive anyone seeing it for the first time.

It is not a purchase at all, and no weight whatever can be lifted at W. If we suppose that a weight lying on the deck is attached by a rope to the block C, and that a strain is put on P, what will happen is this: The rope D E F G will render right around the blocks A and C just as though the rope were fast to B, while the latter will consequently move down to C, where it will jam, and the original relation of the rope and blocks becomes entirely changed. So long however, as the purchase remains in the condition shown in the figure, the rope will simply render around A and C and lift nothing, as a moment's examination of the diagram will show.

This arrangement of rope and blocks is frequently known as the "Jackass Purchase," and the fitting character of the name is not apt to be called in question except by those who have been taken in by it.

Q.—How do you proportion the size of a marine boiler to the size of the engine? WATERTENDER.

A.—Assuming that you refer to the usual type of Scotch boiler, and that with the size of the engine there will be known its general characteristics, including steam pressure and revolutions, and, in fact, all data necessary to the determination of the I. H. P., and to the formation of an intelligent opinion as to its economic performance. At least, this data must be in hand before an intelligent step can be made toward the design of the boiler. For the present purpose, then, all that is necessary to consider is that it is the business of the boiler to furnish steam of a given pressure to the engine, and the requirement to be met is therefore most naturally expressed in terms of the hourly consumption of steam of the given pressure. To design a properly proportioned boiler, which under the given or assumed conditions shall be able to provide the required amount of steam, reference must be had to actual experience with boilers of similar type working under similar conditions. The details of the process may be arranged in the following series of steps:

(1) Determine or assume the requirement in lbs. of steam per hour. This must be done having in view the probable economy of the engine which is to be supplied. For modern quadruple and triple expansion engines with steam pressures from 200 to 160 lbs., this figure will range from 12 or 13 to 16 or 17. In warship practice the number of expansions of the steam at full power is usually less than in mercantile practice, and the economy is consequently somewhat poorer. In consequence, somewhat higher figures for steam consumption must be taken in such cases. For compound condensing engines with steam pressures from 140 to 100 lbs., the figures usually range from 16 or 17 to 20; for simple condensing engines from 20 to 30, and for simple non-condensing from 30 to 40 and upward. An appropriate figure having been thus taken for the lbs. of steam per I.H.P. per hour, multiply this by the I.H.P. and the result will be the required total number of lbs. per hour.

(2) Having in view the quality of the coal and the nature of the draft, next assume the number of lbs. of steam which can be evaporated by one lb. of coal. With good coal and moderate or assisted draft this will usually be from 9 to 10. With hard forced draft the conditions will be less favorable to economy, and the figure may drop to from 7 to 9. Having made this estimate, divide the total number of lbs. of steam by the lbs. of steam per lb. of coal, and the quotient will be the lbs. of coal to be burned per hour.

(3) Again having in view the quality of the coal and nature of the draft, assume the number of lbs. of coal which can be burned per square foot of grate surface. With good coal, good firing and natural draft, this will usually be found from 12 to 18. With assisted and forced draft the amount will rise to 20 or 30 or more. Divide the total lbs. of coal per hour by this figure, and the quotient will be the necessary number of square feet of grate surface. This gives one of the most important characteristics of the boiler.

(4) Next assume the ratio between the heating surface and the grate surface. For Scotch boilers this is usually found between 25 and 35, the value being in general higher, as the draft is higher and combustion per square foot of grate surface larger. The grate surface multiplied by this ratio will then give the square feet of heating surface.

(5) As the next step the number of boilers and the number and disposition of the furnaces in each may be decided upon. Modern marine furnaces will provide somewhere about 20 sq. ft. of grate surface each, and with a little trial some combination of furnaces and boilers, either single-ended or double-ended, or both, may be made to suit the given circumstances. The dimensions of the grate and furnace can next be selected, and in this connection it should be remembered that the length of grate be made not greater than 6 ft., as a longer grate is difficult to fire and keep clean. The diameter of the furnace, and hence the width of grate, is usually found between 36 in. and 48 in., the higher the steam pressure, or the greater the number of furnaces in one boiler, the smaller the diameter.

(6) This point being reached, proceed with the further design of one of the units selected. Experience shows that somewhere about 85 per cent. of the heating surface of a Scotch boiler is furnished by the tubes, and the remainder by the furnaces and combustion chambers. Take, therefore, the total heating surface for one boiler, and multiplying by say .85, get the heating surface to be furnished by the tubes.

(7) The length of tube may be taken from 6 in. to 15 in. or 18 in. longer than the grate. Then choose a trial diameter, remembering that boiler tubes are always measured on the outside, and thus find the heating surface on one tube. Then divide this into the heating surface to be furnished by the tubes, as found in (6), and find thus the requisite number of tubes. This result must, however, be checked by a determination of the resulting calorimeter ratio.

(8) The calorimeter is the total cross-sectional area for the passage of the gases measured inside the tubes. To find the inside area of a tube, deduct twice the thickness from the diameter, and find the area of the corresponding circle. This area, multiplied by the number of tubes, will give the calorimeter area desired. The grate surface divided by this calorimeter should give a ratio of from 5 1–2 to 7 or 8, lower as the draft and rate of combustion are higher. If this quotient is too small, the length of the tubes must be increased or the diameter decreased, or both. If the quotient is too large, changes in the contrary direction must be made. After a few trials, a combination of dimensions and proportions will be found by which the various requirements will be fulfilled, and the result may be considered as a consistent disposition of characteristics, having in mind the especial circumstances of the case.

(9) The length of boiler may usually be taken for single-ended boilers from 36 in. to 42 in. longer than the tubes, and for double ended boilers perhaps 6 in. shorter than twice the length of a similar single-ended boiler.

(10) To determine the diameter of boiler, the drawing board must be resorted to, and by trial it must be found what diameter is necessary to accommodate, with the necessary clearance and usual proportion of steam room, the furnaces and tubes specified in the foregoing.

Thus the chief characteristics of the boiler have been found, and from this point on the design is principally a matter of structural detail. There are many different ways besides those here stated in which you may proceed from the given data to the desired characteristics. Thus you may pass directly from the I.H.P. to the coal per hour, or to the grate surface, or to the heating surface. The method outlined above, however, is probably the safest and most convenient for connecting the given conditions, and special circumstances as to coal, draft, etc., with the necessary characteristics of the boiler. These other relations may then be used as checks in order to make sure that the entire combination forms a mutually consistent whole. With triple expansion engines the coal per I.H.P. per hour is usually found from 1.5 to 2 lbs., the I.H.P. per sq. ft. of grate surface from 10 to 15, and the heating surface per I.H.P. from 2 to 3 or 3.5.

Example:

Required to design boilers for triple expansion engines intended to develop 6,000 I.H.P.

(1) Assume engine will require 15 lbs. steam per I.H.P. per hour. Then $6,000 \times 15 = 90,000$ lbs. *steam per hour.*

(2) Assume 1 lb. of coal will evaporate 8 lbs. of steam. Then $90,000 \div 8 = 11,250$ *lbs. of coal per hour.*

(3) Assume moderate forced draft giving a combustion of 22 lbs. of coal per sq. ft. of grate. Then $11,250 \div 22 = 511 =$ *grate surface.*

(4) Take heating surface ÷ grate surface = 33. Then $511 \times 33 = 16,863 =$ *heating surface.*

(5) Take first each furnace as giving about 20 sq. ft. of grate. Then the number of furnaces would be $511 \div 20$, or 25 and a fraction. The number of furnaces must be exact and should be a multiple of 4 or 3 or both, so as to make possible a suitable subdivision of boilers. In this case, then, take 24 furnaces each of $511 \div 24$, or 21.3 sq. ft. area. This number of furnaces may then be combined in various ways. They could be variously disposed, thus: Eight 3-furnace single-ended boilers, or four 3-furnace double-ended, or six 4-furnace single ended, or three 3-furnace double-ended and two 3-furnace single-ended, or two 4-furnace double-ended and two 4-furnace single-ended, etc., etc. The grate surface in one furnace being 21.3, next take its dimensions as follows:

Width of grate.....3.5 ft., or 42 in.
Length of grate.....6 ft. 1 in.

A length of 6 ft. and area of 21 sq. ft. will be sufficiently near to the requirements.

(6) Now go on with the further design of one of the three-furnace single-ended boilers, as follows:

The grate surface will be 3 × 21.3, or 63.9.
The heating surface will be 16,863 ÷ 8 = 2,108.
85 per cent. of this is 1,792.
(7) Take for trial the tubes 3 in. diam. and 7 ft. long. Then heating surface of one tube is 5.5 sq. ft., and 1,792 ÷ 5.5 = 326 tubes.
(8) Take the thickness of tubes as No. 8, or .17 in.
Then, dia. of hole = 2.64 in, area = 5.47 sq. in., and total calorimeter = 5.47 × 326 ÷ 144 sq. ft. = 12.38.
Then, 63.9 ÷ 12.38 = 5.16.
This is small and indicates the use of longer or smaller tubes, or both. With tubes 2 3-4 dia. and 7 ft. 3 in. long, the result by the same process would be:

No. of tubes, 343.
Calorimeter area, 10.86.
Calorimeter ratio, 5.88.

Or, with tubes 2 1-2 in. dia. and 7 ft. 6 in. long, as follows:

No. of tubes, 365.
Calorimeter area, 9.28.
Calorimeter ratio, 6.89.

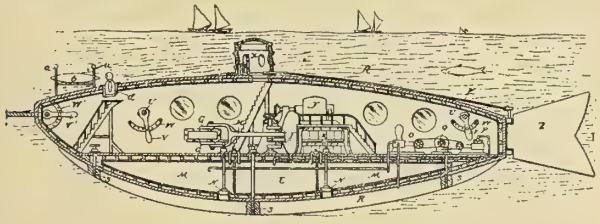
Either of the latter arrangements might be expected to give satisfactory results, and a choice between them would depend on secondary considerations beyond the scope of this discussion.
For check ratios these are important:

Coal per I.H.P. per hour..... = $\frac{11250}{6000}$ = 1.875
I.H.P. per sq. ft. of G. S..... = $\frac{6000}{511}$ = 12 app.
H. S. per I.H.P ..... = $\frac{16853}{6000}$ = 2.81

SELECTED PATENTS.

604,185. SUBMARINE BOAT. *George W. Bennum, Georgetown, Del. Filed June 18, 1897.*

In a submarine boat, pockets formed in the sides thereof, shafts journaled vertically in the pockets and projecting to the interior of the boat, shanks on the shafts, fins pivoted to the shanks to swing vertically, a crank-shaft journaled in the boat, pitmen extending from the inner ends of the first-named shafts to the crank-shaft, and means for driving the crank-shaft. In combination with a submarine boat, a shaft journaled across the bow of the boat and extending to the exterior, at its ends, a blade secured to the ends of the shaft, a lever secured to the interior portion of the shaft, a segment having holes therethrough and a pin adapted to be passed through a hole in the lever into a hole in the segment. In a submarine boat, pockets formed in the sides thereof, shafts journaled vertically therein, shanks secured on the shafts, fin propeller-blades hinged to the shanks to swing vertically, stops on the shanks and lugs on the propellers



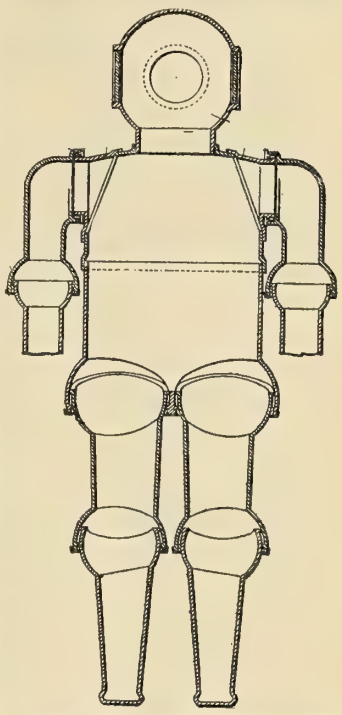
BENNUM SUBMARINE BOAT.

adapted to come in contact with the stops. Propelling mechanism consisting of vertical shafts, ratchet-wheels on the shafts, pawls to engage the ratchet-wheels, gear-teeth on the upper face of the ratchet-wheels, shanks on the shafts, propeller-blades journaled thereon, gear-teeth on the propeller-blades meshing with the first-mentioned gear-teeth.

601,729. DIVING APPARATUS. *William R. Fasey, London, England. Filed March 11, 1897.*

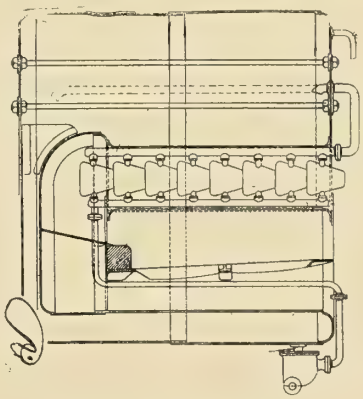
In an improved diving-dress constructed from metal sections, joints connecting the various parts formed from a hemispherical socket on one part, and a hemispherical enlargement on the adjacent part fitting into the socket closely, flanges limiting the motion of the parts and packing forming a water-tight joint.

In an improved diving-dress formed from metal sections connected together, the combination with ball-and-socket joints at the elbows, hips and knees and leather packing in the joints, of flanges on the shoulder-piece, an enlargement at the top of the upper arm-piece, channeled leather packing placed in the groove formed by the enlarged part and a screwed ring completing the joint. In an improved diving-dress constructed from metal and made in sections connected together, joints for the elbows, hips, and knees, formed from a hemispherical socket on one part, a hemispherical enlargement on the adjacent part pivoted to and fitting closely in the socket, flanges on the inside of the socket and on the enlargement and limiting the motion, packing formed from a channeled leather ring placed in the joint and a screwed ring fixing the packing in place. The combination with a metal body-piece, a head-piece screwed into the top of the body, upper and lower arm-pieces and upper and lower leg-pieces all constructed from metal of ball-and-socket joints for the elbow, hips and knees formed from hemispherical enlargements on the ends of the parts pivoted together flanges on these enlargements channeled leather packing-rings and screwed rings holding the packing in place, and shoulder-joints formed from flanges on the shoulder-pieces, enlargements on the upper ends of the arm-pieces leather packing-rings in the channel so formed and screwed rings completing the joint.



599,854. STEAM-BOILER FOR MARINE ENGINES. *Edward Makin, Jr., Manchester, England. Filed May 20, 1897. Patented in England August 6, 1896.*

In combination with the boiler, a steam-generator comprising a series of hollow-walled cones with pipe connections, and a steam-superheater comprising a



MAKIN MARINE BOILER.

series of hollow-walled cones with pipe connections, said generator and superheater being confined within a fire tube or tubes, as described.

NEW PUBLICATIONS.

ETUDES SUR LA MARINE DE GUERRE. Reprinted from the Revue des Deux-Mondes, with additions, and six warship plans and three maps. Berger-Levrault & Cie., Libraires-Editeurs, Paris, 5, Rue des Beaux-Arts. Size, 5 1-2 by 9. Pages, 311. Paper covers, 5 fr.

This volume is a collection of five essays on naval strategy and allied subjects published in the *Revue des Deux Mondes* between 1889 and 1897. The topics treated are as follows: Naval Strategy, Naval Tactics, Cruisers and Scouts, The German Ship Canal and Modern Fleets, The Logical Constitution of the French Naval Force. In the first essay the fundamental principles of all strategy are discussed, and particular applications are made to the conditions affecting naval warfare. Use is made of historical illustrations distributed through the past century, and the point is brought out that while tactics must change with the characteristics of the ship, strategy remains, after all, much the same. The author starts from the central proposition that the chief objective of a naval fleet must be to to meet and destroy the principal fleet of the enemy, and that all naval strategy must take its inspiration from this principle. In the second essay the relations between the characteristics of modern warships and the most suitable formations and evolutions both for cruising and for war are ably and clearly discussed. In the third essay the author presents his ideal of two types of warships, one a commerce destroying cruiser of great endurance, whose rôle shall be to keep the sea for long periods of time in the track of the enemy's commerce, avoiding by superior speed a battle with the enemy's ships of superior armament, and effecting the utmost possible damage in this particular field of naval warfare. The chief characteristics of this ship are as follows: Displacement, 12,000 tons; I. H. P., 30,000; speed, 24 knots; coal capacity, 3,000 tons; armament, one 5 1-2 in. gun forward; twenty-four 4 in. guns, one 8 in. mortar aft, with light rapid firers according to choice. The ram bow and torpedo equipment are omitted, and coal protection is made to do duty for a protective deck. This is intended as a type of vessel entirely specialized and with but one objective—the capture of mercantile ships. Issue might be taken regarding some features in detail, but all will agree that by sticking strictly to her business such a ship should be capable of a vast amount of damage to mercantile shipping of all classes. The author's ideal of a scout ship is developed from the proposition that the place for most effective scouting is near the enemy's fleet rather than near her own, and that as a division the scout ships must provide as nearly as possible a continuous fund of information regarding the location and movements of the enemy. The chief characteristics of such a scout are given thus: Displacement, 6,000 tons; I. H. P., 13,000; speed, 21 knots; coal, 1,200 tons; armament, main battery of 8 in. and 6 in. or 5 1-2 in. guns, with secondary battery to correspond; protection, deck and 4 in. to 5 in. of side armor. This type of scout is therefore a rather small armored cruiser with fair speed and moderate battery power, and is, of course, intended for fighting in the latter stages of a campaign, as well as scouting in the earlier. In the fourth essay the history of the German ship canal is summarized, and its probable effect on the tactics of the German navy is discussed in an interesting and comprehensive manner. In the last essay the author developes his ideal of the French fleet upon the supposition that the combined fleets of the Triple Alliance in the Mediterranean and on the North must be dealt with. The author's development of the subject is interesting and forceful, and he concludes that to fulfil the purposes desired, France should have a fleet of about 650,000 tons of all classes, while in fact the sum reaches to but 480,000 tons. In this essay the designers of some of the recent French ships are taken to task for their apparent sacrifice of offensive for defensive qualities, and here, as elsewhere in the book, the well known principle is insisted upon that to make war is to attack. As a whole, these essays are written in an admirably clear and forcible style, and while one may not always agree in detail with the conclusions reached by the author, it is always a pleasure to read a book where the bases of the conclusions are presented in so clear and forcible a manner. The essays are reproduced without change as they first appeared, and in some details, as stated in the preface, the author has found reason to modify his earlier views, but has preferred to present them as originally written in order to show the development of the subject in his own mind. Several notes at the end of the volume bring the older essays down to date, however, and thus make of the book, as a whole, a presentation of the subject from the latest points of view. Plans of several warships of the French and other navies are given in illustration of some of the types of ships, as well as maps of the German ship canal. The last word on naval strategy and tactics seems still a long way off, longer, perhaps, since the events of the immediate past in the Spanish-American war than it seemed before. Just what the final teachings of the past few months may be it is too soon to consider at present, but one of them, at least, is that naval strategy can never be entirely worked out on paper nor developed independently of experience in actual sea battles. But while this is true it is none the less desirable that these problems should be constantly studied and that books should be written and read, for this means thought and preparation for a more intelligent analysis and use of such facts of experience as may from time to time be provided.

A MANUAL ON LAYING OFF IRON STEEL AND COMPOSITE VESSELS. By Thomas H. Watson, Lecturer on Naval Architecture at the Durham College of Science, Newcastle-upon-Tyne, England. Longmans, Green & Co., New York and London. First Edition, 1898. Size, 6 1-2 by 10. Pages, 160. With Numerous Illustrations. Cloth, $5.00.

This work, to quote from the preface, was written to meet a need amongst junior ship draughtsmen, apprentice loftsmen and class students. The subject of mercantile vessels is first taken up, and the entire field is covered in twelve chapters under the following heads: Laying off the sheer draught on the loft floor, Cant frames, decks, floors and double bottoms, Shell plating, Scrieve boards, Ribbands and harpins, Moulds, Poop round and turtle back, Expansion of Stringer plate and beam knees, Iron and steel masts, Miscellaneous. Warship design is then taken up, and, to avoid repetition, the discussion covers only the essentially peculiar features, such as protective decks, belt armor, turrets and barbettes, bilge keels, ram bow, inner bottom, etc. Such special points of difference as may arise in composite and sheathed vessels are also treated in separate chapters. As a whole, this work forms the most extended treatise on this special field of ship design with which we are acquainted. The text, though in condensed style, has been prepared with care, and the subdivision into chapters and subheads, together with the index, make it convenient of use for miscellaneous reference. The illustrations, which form naturally an especial feature in a book on this subject, are copious in amount, selected with judgment, and prepared with care. The author presupposes naturally considerable acquaintance with the operations of general drawing and with ship construction, though he is careful to define most of the more important technical terms as they are introduced. The

special knowledge assumed, however, is not more than should be possessed by those for whom the book is intended, and all such should follow the author without difficulty. It is safe to say that any one who works through the book intelligently should be well equipped to deal with all problems likely to arise in the geometrical part of ship design. The book represents more especially the practice on the Northeast Coast of England; but the range of illustration is wide; many alternate methods are given, and such differences as may exist between the methods here given and those in vogue at other places only relate to matters of minor detail, and for the student especially they are therefore quite unimportant. The laying off of ships is, of course, but a special application of descriptive geometry, or of the simple theory of projections to the particular problems arising in the geometry of ship design, and there is much in the book that would be unnecessary to the well-prepared class student. For the latter a good grounding in descriptive geometry and a proper acquaintance with practical ship construction leave little beyond the points of practical technique to be supplied in a treatise on laying off. For the other classes for which the book was designed, however, such is not the case, and the more comprehensive treatment becomes appropriate. In any event it is well that there should be a book giving a comprehensive treatment of this subject, and all interested in the solution of mould loft problems may be congratulated on having so excellent a compendium of practical and reliable methods placed within their reach. The book is well printed on excellent paper, and the entire make-up shows both care and skill on the part of the publisher. The combination of so many folding plates with the text makes the binder's task one of unusual difficulty, but it has been successfully accomplished, and both author and publisher may be congratulated on the production of so thorough and comprehensive a work in a field which has hitherto attracted so little attention from the writers of books.

MANNING'S YACHT REGISTER FOR 1898, *with which is incorporated The American Yacht List.* In two parts, with colored plates, showing Yacht Club Flags and Private Signals of Owners. Thomas Manning, proprietor and publisher, 45 Broadway, New York. Size 8 by 10. Pages 514. Cloth, $10.00.

The latest edition of this valuable reference book, just published, is quite up to the high standard set by the publisher. Part I. contains, among other matters, a register of Recognized Yacht Clubs of the United States and British Provinces; also Lists of Officers, Addresses of Secretaries, Names of Yachts, Official Numbers, Signal Letters, Dimensions, Designers, Builders, and many plates containing facsimilies in chromo-lithograph of Club Flags and Private Signals of Owners. Part II, which contains 196 pages of text, giving particulars of Yacht Club Regattas and Races for 1897, compiled from official sources only. These include Names of Yachts, Racing Lengths, Time Allowance, Club Rules, Weather during Races, Course Distances, Number of Starters, Times of Starting and Finishing, together with Elapsed and Corrected Times and Results, Names of Helmsmen; also a record of the Rules for the America's, Cape May and Brenton's Reef challenge cups. This mass of detailed particulars is properly assorted and arranged for ready reference, the typographical scheme being particularly clear. The mere enumeration of the contents is sufficient to show the value of the work to those interested. It is highly creditable indeed to American yachting interests that anyone should be found who would so enthusiastically undertake this laborious work with such excellent results. No yachting or marine library can be complete without this yacht register, which, considering the necessarily restricted sale of such a work, and the splendid manner in which it has been put out, is sold at a remarkably low price.

RECENT PUBLICATIONS.

"Triple and Quadruple Expansion Engines and Their Management" is the name given a 250 page book by A. Ritchie Leask, the author and publisher. It is now in the third edition—recently published—and is likely to run into several more. As the name would indicate, the book is thoroughly practical throughout, giving in plain language the suggestions and instructions under the several headings. These are grouped in ten chapters, which commence with a summary of the advantages of using steam expansively, then in turn Packing Rings, Slide Valves, Jacketing and Details of Design, Bearings and Auxiliaries, Boilers and various forms of Draft, Liquid Fuel, Working of Boilers at Sea, Care and Operation of Engines and Boilers and Specifications for Marine Machinery are treated, with much additional matter not here referred to by name. There are about 50 illustrations in explanation of the text. To those not familiar with the more improved forms of marine apparatus the book would be immensely helpful, and those who have had much experience in this direction can find a variety of useful pointers in its pages. Books of this practical character are not numerous, and especially those which are not written over the heads of subordinates who desire to fit themselves for responsible positions in charge of marine machinery. This book will be a great aid to such. The American agents of the publisher are Spon & Chamberlain, 12 Cortlandt street, New York.

"Electric Lighting for Marine Engineers" suggests a particularly useful book covering a field in which many of the older engineers have had no youthful training. The introduction of electric lighting on board ship has been so rapid and extensive that, except in vessels large enough to carry a separate electrical staff, there is real need for knowledge of the principles and practice of electricity. The book is the work of Sydney F. Walker, a distinguished English electrical engineer. It is now in the second edition. It is divided into chapters under these heads: Glossary of Terms, Dynamo Machines, Cables and Branch Wires, Electric Lamps and Fittings, Switches, Fuses and Cut-outs, Measuring Instruments, Faults and How to Remedy Them, Use of Electric Light in Petroleum Ships, and Cargo and Search Lights. The book contains about 300 pages and is of convenient size for desk use. There is a considerable number of drawings and engravings of electrical apparatus. In criticism it might be said of the book that the reader hardly progresses in sufficiently easy stages to correctly comprehend the working of modern generators, and there seems to be an undue amount of space given to fittings. It is a very useful book, however, within its limitations and might well form one of a set of books for constant reference. The selling price is 5s., and the publishers are Whittaker & Co., Paternoster Square, London, E. C., England.

"Drawing and Designing for Marine Engineers," by Charles W. Roberts, member of the British Institute of Marine Engineers, has become a standard work in the special field which it covers. It was written primarily for the education of marine engineers who intended to take the British Board of Trade examinations for certificates, and also for those engaged in marine work who have had no opportunity to gain experience in an engine builders' drawing-room. The general contents include chapters on: Drawing Instruments, Projection of Draw-

ings, Designing Cylinders and Slide Valves, Piston and Connecting-Rods and Shafting, Bed Plate, Condenser, Pumps and Pipes, Screw Propeller, Marine Boiler and Boiler Mountings. There are about thirty illustrations in the text, and twenty plates containing good, bold drawings, in just the style that every progressive engineer would like to be able to send out shop drawings. The book is not as elementary as a novice would desire, but for those who have some knowledge of geometry and a quick perception for graphic representation the book is very valuable. As a book of suggestions for draughtsmen or designers it has special merits. It is very practical and simple throughout, and would not strain the mathematical faculties of the student. The book is desk size, with 182 pages of very clear type. The publishers are Whittaker & Co., White Hart Street, Paternoster Square, London, and the price of the book is 6s.

Among the scientific naval periodicals of the day, which are published by various maritime nations, the Journal of the American Society of Naval Engineers holds a very high position. The completeness of its technical articles on the vessels of our Navy, the high character of the scientific papers printed in it (many of them read at meetings of the Society) and the well arranged mass of information about the mercantile marine and marine engineering matters in general, make this publication of immense present value and invaluable as a work of reference. To facilitate its use for the latter purpose the Society has printed a General Index of the Volumes I to VIII, 1889-1896 inclusive. Within the space of sixty-seven pages the reader is thus put in touch with a whole library of titles of articles, such as are noted in the foregoing. The possession of this general index makes it unnecessary to go through the separate indexes of each volume, and is especially useful to those who have incomplete sets. The index can be had by remitting $1.50 to W. M. McFarland, Passed Assistant Engineer, U. S. N., Secretary-Treasurer of the Society, Navy Department, Washington, D. C.

"Refrigerating and Ice-Making Machinery" has appeared in a second edition with additions. It covers very completely the various systems in use without, of course, special reference to the installation of such apparatus on ships. It is conveniently divided into sections, treating in turn of the general laws which apply to Methods of Refrigeration, the Vacuum Process, the Compression Process, the Absorption Process, the Cold Air System; also Discussion of Fittings, Construction and Arrangement of Cooling Rooms, Industrial Applications, Ice Making, and finally Questions of Cost. The author's style is clear and good, and he has written a book which the average practical man can read and remember. The book contains 280 pages, is a very portable size and is well illustrated. A. J. Wallis-Taylor is the author, and the publishers are Crosby, Lockwood & Son, 7 Stationers' Hall Court, Ludgate Hill, London. The selling price is 7s. 6d.

The Coast Defence Edition of the Scientific American Supplement, just issued, treats of land defences in the same manner as the Naval Supplement covered the sea forces of the United States. It is an exceedingly useful issue, in that it contains inside one cover matter which could only be found outside in a great mass of publications. It treats of guns, armor and fortifications, giving types, methods of construction and operation, armor plate manufacture and tests, and disposition of guns at various coast points. There is also much matter on explosives, torpedoes and small arms, and comparative tables of large breech loaders. The illustrations are extremely numerous and well executed and fully descriptive of the text. Munn & Co., 361 Broadway, New York, are the publishers, and the selling price is 25 cents.

TRADE PUBLICATIONS.

A catalogue and price list of paints, colors, varnishes, etc., is issued by Harrison Bros. & Co., Inc., Philadelphia, Pa. This company also issues a pamphlet entitled, "Chemistry of Paints," which is well worth the reading by users of paint.

A Catalogue of Various Pneumatic Tools, such as riveters, caulking tools, etc., is just issued by the Ridgely & Johnson Tool Co., Springfield, Ill. The various tools are well illustrated, showing them in use for ship work, etc., making the catalogue a very useful one.

"The Confessions of an Oil Fiend" is the title of a 3 in. by 6 in. booklet issued by McVicar & Sweet, Denver, Col. It has much information regarding the McVicar oiler, which every engineer will find worth reading. Copies can be had by mentioning Marine Engineering.

A neatly printed booklet 7 in. square has just been issued by the International Correspondence Schools., P. O. Box 1111, Scranton, Pa. It is printed in red and green, on light green paper, and gives a great deal of information valuable to all of those interested in technical education, and explains in detail what correspondence instruction is.

The Davidson Fan Wheel, for purposes of ventilation, etc., is well illustrated in a twenty-eight page neatly bound and well printed catalogue just issued. Many illustrations and tables in connection with the reading matter make the contents complete. Copies of the catalogue can be had from the Massachusetts Fan Co., 53 State St., Boston, Mass.

"Graphite as a Lubricant Scientifically and Practically Considered; Also, Its Value as an Accessory for Engineers and Machinists." The sixth edition of this pamphlet revised and brought up to date has just been issued by the Joseph Dixon Crucible Co., Jersey City, N. J. It comprises thirty-two well filled pages and contains much valuable information on the subject in question.

A series of bulletins regarding electrical machinery is issued by the C. & C. Electric Co., 143 Liberty St., New York, the last three being devoted to bipolar dynamos and motors, ironclad dynamos and motors, and multipolar dynamos and motors. These bulletins are very handsomely printed and contain much valuable information. Copies can be had by referring to Marine Engineering and sending to the company.

"The Paint Question" is fully discussed in a 4 in. by 8 in. pamphlet of 30 pages. It is intended to be a practical treatise on the selection and use of paint and is written by Stanton Dudley, author of "Paint Talks." The reading matter is carefully arranged under headings, and a table of contents is given for ready reference. Users of paint should send for a copy of this to the New Jersey Zinc Co., 52 Wall St., New York.

"Air Compressors" is the latest catalogue issued by the Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York. It is 6 in. by 9 in. in size and contains about 100 pages, finely printed in red and black and with complete index. Compressed air has become so generally used in ship yards for operating hand tools that a complete catalogue like this will be much appreciated. It is fully illustrated, showing every type of compressor.

The Foster Engineering Co., Newark, N. J., has just published a catalogue of the various "Foster" devices, including reducing valve, pump speed governors regulator valves, etc. The catalogue is 6 in. by 9 in. in size, of sixty-four pages and contains many illustrations of the various devices referred to. The cover is printed in black and gold and has a large embossed cut of the "Foster" valve. There is much in this catalogue to interest every man connected with steam engineering.

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

REDUCING VALVES

to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.

BUSINESS NOTES.

NEW YORK HEADQUARTERS.—An office and storeroom of the Eynon-Evans Mfg. Co., Philadelphia, has been opened at 107 Liberty St., New York, where can always be found a full line of injectors, bilge pumps and many other specialties manufactured by this company.

MARINE HARDWARE.—Owing to the great extension of its business, the Enos Sheet Holder Co., Peabody, Mass., has been organized into a stock company with $60,000 capital stock, and during the coming season will be even better prepared than ever to handle business promptly.

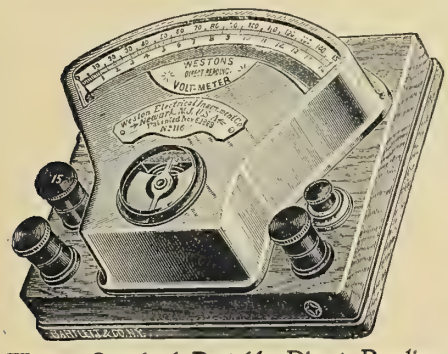
PIPE WRENCHES.—The twelve river steamers illustrated in the July number of Marine Engineering before launching at Moran Bros. shipyard, Seattle, Wash., were all fitted out with Vulcan Chain Pipe Wrenches furnished by J. H. Williams & Co., 9-31 Richards St., Brooklyn, N. Y.

A MODEL MARINE ELECTRIC PLANT.—Those of our readers interested in electricity should send for a small picture of a very attractive electric plant. The dynamo is the Riker manufactured by the Riker Electric Co., 45 York street, Brooklyn, N. Y., and the engine is a Wellington made by the Fore River Engine Co., Weymouth, Mass.

NEW PROPELLER WHEELS.—The "Perfect" propeller wheel, designed by Captain Samuel Golden, 178 Ohio St., Buffalo, has recently been given a test. The Buffalo police boat was equipped with one, and Captain Pritchard of the boat says it drives the boat faster than before and has greatly reduced vibration, even when the engine is working to its full capacity.

GOOD BUSINESS REPORT.—The manufacturers of the Lee injector and other steam specialties write us that when they started their factory a year ago they put in a six H. P. engine, but owing to the rapid growth of their business in all parts of the United States, Canada, British Columbia and Mexico, they have been compelled to add new machinery and tools and replace their six H. P. engine with a 20 H. P. The manufacturers are the Lee-Penberthy Mfg. Co., Detroit, Mich.

MARINE RAILWAYS.—It may not be generally known that the Halifax, Nova Scotia Graving Dock Co., in whose fine dry dock the Battleship Indiana was docked some time ago, has at the same port also a fine marine railway plant, consisting of four marine railways, all of which were built by the firm of H. I. Crandall & Son., East Boston, Mass. The capacities of these range from 150 tons to 2,700 tons weight, and they handle from 500 to 550 vessels per year. The largest railway, of 2,700 tons capacity, was built in 1863, and Messrs. Crandall & Son are about to start the work of rebuilding it and putting it in up-to-date condition.



Weston Standard Portable Direct Reading Voltmeter.

WESTON STANDARD PORTABLE

DIRECT READING

VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Intruments are recognized as **THE STANDARD** the world over. Our **STATION VOLTMETERS** and **AMMETERS** are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.,
114-120 William St., NEWARK, N. J., U. S. A.

A Fine Display of Pumps.—At the present electrical exhibition in Philadelphia one of the finest exhibits was of Worthington pumps made under the auspices of the Philadelphia agents, Messrs. Fred and William Doran, who have offices at 724 Arch St.

Metal Polish.—The Imperial Metal Polish manufactured by the Rath Mfg. Co., Philadelphia, is handled in the New York market by William E. Burton, 18 and 20 Liberty St., who carries a large supply at all times and is ready to answer any inquiries.

Propeller Stern Pipe Packing.—The packing of the propeller stern pipe has been a difficult piece of work and is believed to be overcome by the use of the rawhide packing manufactured by the Mabbs Hydraulic Packing Co., P. O. Box 829, Chicago, Ill. Water is the best lubricant for rawhide and makes it anti-frictional. This packing has stood years of tests and is easily applied. Full information and circulars may be had by applying to the company.

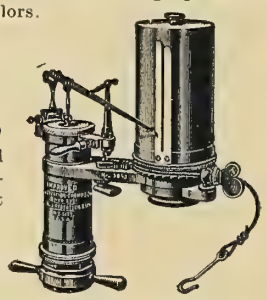
SEND 2 LABELS

cut from front of boxes of EUREKA PACKING and we will send you a pack of beautiful playing cards. All being special in 3 colors.

MARINE ENGINEERS

should own an INDICATOR and know how to use it. Send for circular and *special* prices. It will interest you.

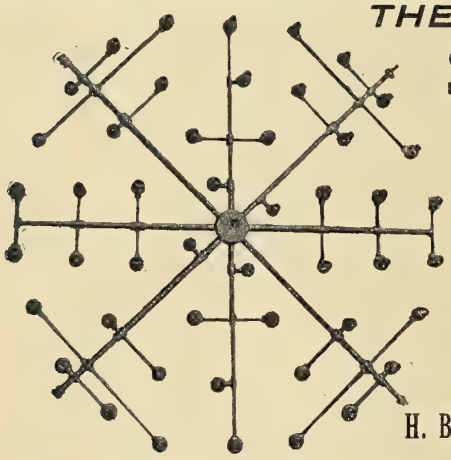
Jas. L. Robertson & Son,
218 Fulton St., N. Y.



THE IMPROVED ANNULAR

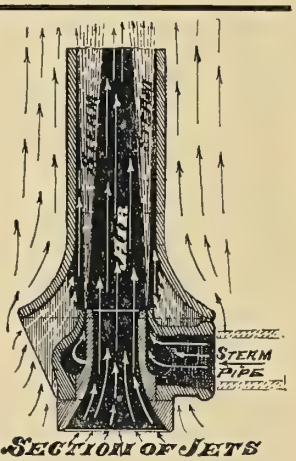
STEAM JET.

POWERFUL—ECONOMICAL.



Gives draft equal to a fan. Can be applied to any stack, and will greatly increase the draft with a minimum amount of steam. Cuts show section of a jet and spider to which they are attached.

Send for circulars and list of steamers on which it is used.



Section of Jets

H. BLOOMSBURG & CO., NEWPORT NEWS, VA.

Northern Steamship Co.

Office of the Agent.

Buffalo, N.Y. Oct., 8, 1897.

Regal Packing Co.,

Chicago, Ill.

Gentlemen:-

Replying to your inquiry as to the merits of your Regal Metallic packing as shown by its use on the Engines and other machinery of the Steamship North West, it gives me pleasure to report that it is giving unqualified satisfaction in every place where it has been applied.

We are now using it in the stuffing boxes on one of our main Quadruple Expansion Engines (of 3000 H.P.), as well as in our pumps, injectors, etc., which operate in connection with our Belleville Boilers, and also in other places where packing of unusual character is required against high pressures, or to endure severe service either for water or steam.

We carry 267 lbs. boiler pressure and steam at 200 lbs. is delivered to our high pressure cylinders. This will afford some idea of the character of the packing we require, and I am pleased to state that your Regal Packing has met this demand perfectly.

As a matter very important to Engineers, your packing contains a lubricating element which is constant, and for that reason there is a very appreciable reduction in the amount of friction on all rods and stems and a consequent reduction in the amount of wear thereon.

I sincerely believe your Regal Metallic packing superior to anything I have known and its economy is unquestioned since it can be used over and over again for all time. I have nothing but good words for it, and I am sure every Engineer will use nothing else when once its value is understood.

Very truly yours,

John A. Currier

Chief Engineer

Str. North West.

I take pleasure in endorsing the above Meyers Boycell

REGAL Metallic Packing.

Descriptive booklet sent on application.

Regal Packing Company,

Fisher Building, Chicago, Ill.

ZINC FOR THE HULLS OF VESSELS.

In painting the hulls of ocean going vessels two purposes are in view; the first to protect the material from corrosion and the second to resist the destructive attacks of marine life. To accomplish the first-named purpose, the coating applied should be as impervious as practicable to water, and as resistant as possible to the chemical action of the marine salts. The second named object is attained to a certain, not altogether satisfactory, extent, by the use either of poisonous materials (copper, arsenic, carbo ates, etc.), or by the application of a material too soft to afford a secure lodgment to the parasitic growths.

The most satisfactory of the water and chemical resisting media is oil, as is evidenced by the time-honored practice of giving to iron ships' plates a preliminary bath of hot linseed oil. On the value of this first coating, experts practically agree, but in regard to the subsequent treatment there is a great diversity of opinion, with the preponderance perhaps in favor of red-lead. Logically, however, no form of lead paint appears to be naturally adapted to this use, as the lead compounds are all subject to decomposition by sea water, all carry a relatively small proportion of oil in combination, and all, more or less, form with linseed oil, a compartively soluble metallic soap. Perhaps these defects would have impressed themselves more effectually upon the minds of ship-building authorities had it not been the general custom to shield the coatings of lead paint with a final coat of more resistant material.

A paint made with red-lead carries to the painted surface a very small proportion of oil, and therefore the particles of lead-oxide are imperfectly protected against chemical action, to which it is very subject, being strongly basic. Zinc-white, on the other hand, carries a higher percentage of oil 48 to 50 per cent.) than any other pigment available for the purpose, does not saponify the oil, and is chemically inert under all marine conditions. It also retains its pure white color indefinitely, and these qualities probably account for its adoption by the United States Government for painting the famous "White Squadron."

If red-lead be used on ships' hulls, it should be protected with a sufficiently heavy coating of zinc-oxide, or, perhaps better still, the lead should be combined with about 50 per cent. of zinc, and the protective covering of zinc-white, either pure or tinted with stable mineral colors, should be laid on over the combination paint.—*Adv.*

STANTON DUDLEY.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

EXPERIENCED MAN SEEKS POSITION.

Marine engineer, with long and extensive practical experience in the construction and operation of modern high-power marine machinery, desires position with ship and engine builders. Can design and lay out work. Address I. H. P., MARINE ENGINEERING, World Building, New York.

PROFESSIONAL CARD.

H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.

Manufacturer of **Screw Propellers** for Usual and for Special Work.

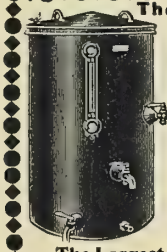
The Allen Dense Air Ice Machine for Steam Vessels.

41 MAIDEN LANE, NEW YORK.

WELLS LIGHTS IN WAR TIME.—Since war operations began, the Wells Light Mfg. Co., 44 and 46 Washington St., New York, has been busy making shipments of lights to various places to meet the needs for brilliant and efficient illumination at fortifications, for coast line defence, etc., which they completely fill. This company has also made a large consignment of lights to Cuba within the past few days, as the Wells Light has proven itself to be one of the very necessary outfits of the war.

MECHANICAL DRAFT.—Travellers passing through Jamaica Plain, Mass., look at the large manufacturing establishment of the B. F. Sturtevant Co., and wonder at the disappearance of the tall boiler chimney, which previously stood as an evidence of so much invested capital. It had, however, outlived its usefulness, and its value was measured only by the possible utilization of its bricks, for a substitute had been installed in the shape of a Sturtevant fan for providing the draught. The invisible products of combustion are now diischarged through a small stack extending such a short distance above the boiler house as to be hardly noticeable.

REDUCED COAL CONSUMPTION.—Last winter the whaleback steamer Thomas Wilson was taken in hand by the Detroit Dry Dock Co., Detroit, Mich., and without other alteration of her machinery the Howden hot draft system was applied to her boilers. Scientific trials were made before the change and afterwards, as assurances were given that a saving in fuel could be made of 15 per cent. The consumption of fuel last year was 2.3 pounds per indicated horse power per hour. Under the assurances it was necessary to reduce the fuel consumption to 1.95 pounds. After the change careful tests were made and it was shown that the fuel consumption was reduced to 1.643 pounds, showing an improvement of 25 per cent. over what the steamer had been doing. It is evident from these figures, which are official from the Dry Dock Co., that the new system would pay for itself in a short time, when properly installed.



The **CROSS OIL FILTER**

actually reduces oil bills 50% or more. Sent on approval. Used in 17 countries. Adapted to steam vessels of every description. Send for circulars, testimonials, etc.

THE BURT MANUFACTURING CO.

AKRON, OHIO, U. S. A.

The Largest Manufacturers of Oil Filters in the World.

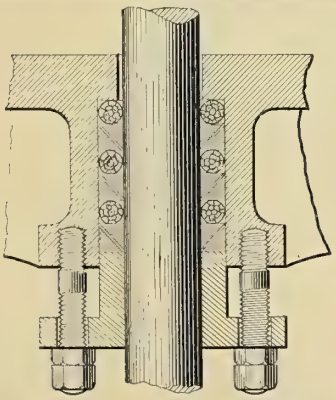


Fig. 1—Packing in position and gland adjusted.

DANIEL'S PATENT P. P. P.

Diagonal Rod Packing.

The most elastic and durable packing for feed pumps, air pumps, hydraulic pumps, and trunk plunger pumps, also for electric engines and all other auxiliary engines and pumps. Special grades for high steam pressures on main engine rods and valve stems, also for ammonia compression pump rods.

Send for sample. Will not score the rods. Manufactured only by

C. A. DANIEL,

409 Market St., Philadelphia, Pa.

Branch Offices: Pittsburg, 105 Water St.; San Francisco, 514 Mission St.; Chicago, 4 S. Canal St.; Toledo, 638 Leonard St.

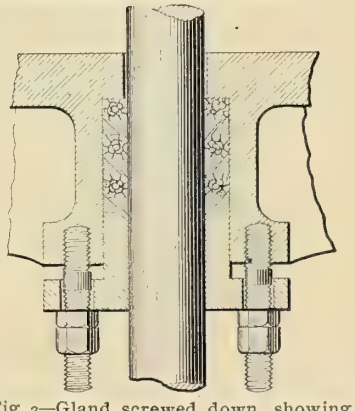


Fig. 2—Gland screwed down, showing how the wedges slide up to compensate for wear.